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FIELD MANUAL

FALLOUT PREDICTION

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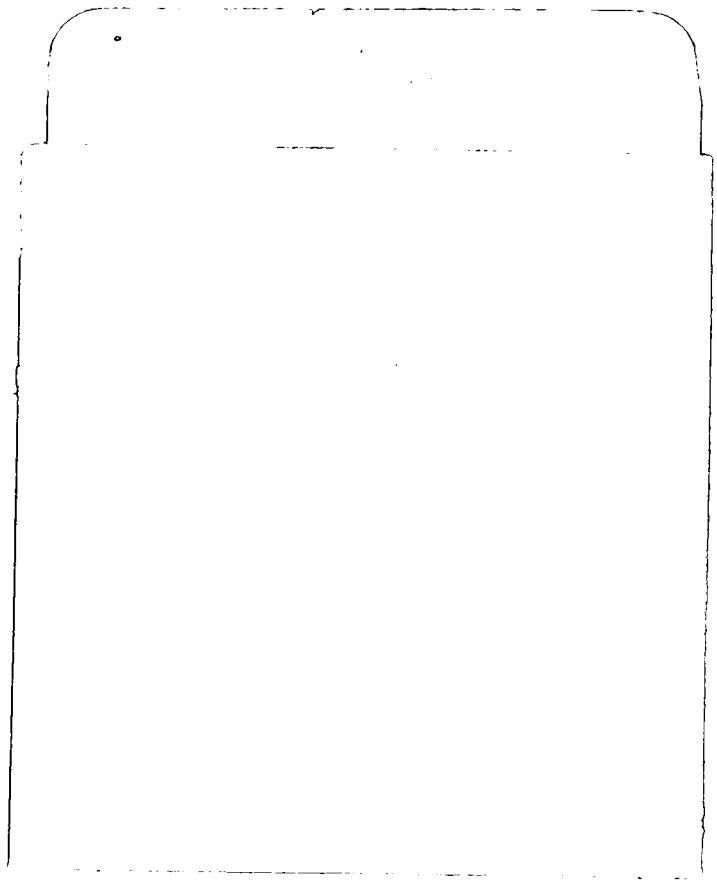
HEADQUARTERS, DEPARTMENT OF THE ARMY
OCTOBER 1973



FIELD MANUAL
No. 3-22

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *30 October 1978*

FALLOUT PREDICTION

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* This manual supersedes TM 3-210, 3 December 1967, including all changes.

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CHAPTER 1

INTRODUCTION TO FALLOUT PREDICTION

1. Purpose

This manual provides guidance in the preparation of detailed and simplified fallout predictions to commanders at all echelons within the Army and provides procedural guidance for those persons operating the Chemical, Biological, and Radiological Element (CBRE).

2. Scope

a. The material presented in this manual is applicable to nuclear warfare conditions.

b. Chapters 1 through 3 of this manual provide guidance in fallout prediction to commanders and staffs within the Army. Sections I through III of chapter 2, section II of chapter 3, and chapter 4 provide more detailed guidance for those personnel (primarily Chemical Corps) who are directly involved in the CBRE functions of major headquarters. Chapters 1 through 3 generally apply to surface or near surface (not underground) bursts. Chapter 4 provides procedures for prediction of fallout from all subsurface bursts. Chapter 5 provides a method of transmitting friendly nuclear strike warning to troop units. Chapter 6 contains tables, graphs, and nomograms used in fallout prediction; these are referred to throughout the manual. Example problems illustrating the procedures used in the preparation of fallout predictions appear in chapters dealing with the detailed and simplified methods and atomic demolition munition (ADM) procedures.

c. This manual is in consonance with the international standardization agreements (STANAG) listed below. These STANAG are identified by type of agreement and number at the beginning of each appropriate chapter in the manual. The following terms are used to describe the types of agreements: NATO STANAG—STANAG applicable to nations of the North Atlantic Treaty Organization; CENTO STANAG—STANAG applicable to nations of the Central Treaty Organization; ABCA QSTAG—Quadripartite Standardization Agreement among the American, British, Canadian, and Australian Armies.

Title	*NATO STANAG*	*CENTO STANAG*	*ABCA QSTAG*
Reporting Nuclear Detonations, Radioactive Fallout, and Biological and Chemical Attacks	2103 (3d Ed)	2103	123
Friendly Nuclear Strike Warning to Armed Forces Operating on Land	2104 (2d Ed)	2104	130

d. Users of this publication are encouraged to recommend changes and submit comments for its improvement. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. **Comments should be** prepared using DA Form 2028, Recommended Changes to Publications, and **forwarded direct to Commandant, US Army Ordnance Center and School, ATTN: ATSL-D, Aberdeen Proving Ground, Maryland 21005.**

3. Need

a. The need for a fallout prediction system stems from the large-area radiological contamination hazard that can develop from fallout-producing nuclear detonations. This large-area hazard is capable of producing mass casualties if its presence is not detected or if commanders at all echelons do not understand its effects and take action to minimize those effects. Thus, fallout has a considerable impact on military planning and operations.

b. There are many occasions when a commander will require a fallout prediction. Four occasions that may occur are discussed below.

(1) When the commander plans the use of a nuclear weapon that lacks a 99-percent probability of being fallout safe or whenever a contact backup fuze is used, a prestrike fallout prediction is prepared as part of the target analysis.

(2) When information indicates that fallout is occurring or that fallout probably will occur from a nuclear burst (friendly or enemy), a fall-

out prediction is required to enable the commander to warn higher, adjacent, and subordinate units.

(3) When a fallout-producing burst occurs, an evaluating procedure is initiated which will answer the commander's questions about the fallout hazard. However, a time lag of several hours to a day or more may occur between the time of burst and the availability of measured data (from radiological monitoring and/or survey) which would permit evaluation of the actual hazard. During this time lag the fallout prediction (area of expected hazard), or at best the fallout prediction supplemented by measured radiation data, may be the only available information for estimating the effects of the radiation hazard on tactical operations or plans. This time lag occurs because—

(*a*) Meaningful measured data cannot be obtained until fallout in an area of interest is complete. Militarily significant fallout in an area may not be complete for a period of several hours after the burst, depending upon the yield, distance from ground zero (GZ), and upper wind structure. The obtaining of measured data may also be delayed by the difficulties of night survey or the operational situation.

(*b*) Several additional hours may be required for the reporting and processing of measured data into usable form.

(4) When information is needed to plan surveys or other aspects of the collection effort, the fallout prediction establishes an outline of the expected hazard that can be used for this purpose.

4. Fallout Prediction Procedures

To satisfy command requirements at all echelons, two procedures for predicting fallout from a single detonation are established as explained below. (For predicting hazards from multiple bursts, see paragraph 20.)

a. The *detailed* method (chap 2) is used by the CBRE in preparing fallout predictions at headquarters having a meteorological capability. These predictions are employed by major commands and subordinate units.

b. The *simplified* method (chap 3) can be used by any unit in preparing fallout predictions. The simplified method employs a simplified fallout predictor which may be either the standard Area Predictor, Radiological Fallout, M5A2, or a field-constructed simplified fallout predictor. In a nuclear war, it may be expected that small, mobile units will be operating in widely dispersed areas. In such situations, receipt of a detailed fallout prediction (NBC 3 (Nuclear) report) from major command headquarters may be delayed for significant periods of time. The simplified procedure provides small units an immediate capability of estimating the location of a potential fallout hazard, thereby allowing greater unit self-sufficiency. The estimate made of the fallout hazard using the simplified method will be less accurate than that made using the detailed method.

5. Significance of Predicted Fallout Zones

a. Inside the Predicted Area. In both simplified prediction and detailed prediction, the predicted zones define those areas within which exposed, unprotected personnel *may* receive militarily significant total doses of nuclear radiation (that which may result in a reduction in their combat effectiveness) within 4 hours *after* actual arrival of fallout. A zone of primary hazard (Zone I) and one of secondary hazard (Zone II) are predicted.

(1) *Zone I* delineates the area of primary hazard and is called the *Zone of Immediate Operational Concern.* It is defined as a zone within which there will be areas where exposed, unprotected personnel may receive doses of 150 rad (the emergency risk dose), or greater, in relatively short periods of time (less than 4 hours after actual arrival of fallout). (A rad is a unit of absorbed dose of radiation equal to one roentgen or one rem for gamma radiation.) Major disruptions of unit operations and casualties among personnel may occur within portions of this zone. The actual areas of major disruption are expected to be smaller than the entire area of Zone I; however, the exact locations cannot be predicted. The exact dose which personnel will receive at any location inside Zone I is dependent upon the dose rate at their location, the time of exposure, and protection available. There is, however, a reasonably high assurance that personnel outside the boundary of Zone I will not be exposed to an emergency risk dose in less than 4 hours. The radiation produced from neutron-induced activity will be closely confined to the area around ground zero, which will be well within the limits of Zone I. The induced radiation will therefore have no effect on the extent of Zone I but will cause higher dose rates in the area around ground zero. Thus, the dose from induced radiation was not considered in determining the extent of Zone I.

(2) *Zone II* delineates the area of secondary hazard and is called the *Zone of Secondary Haz-*

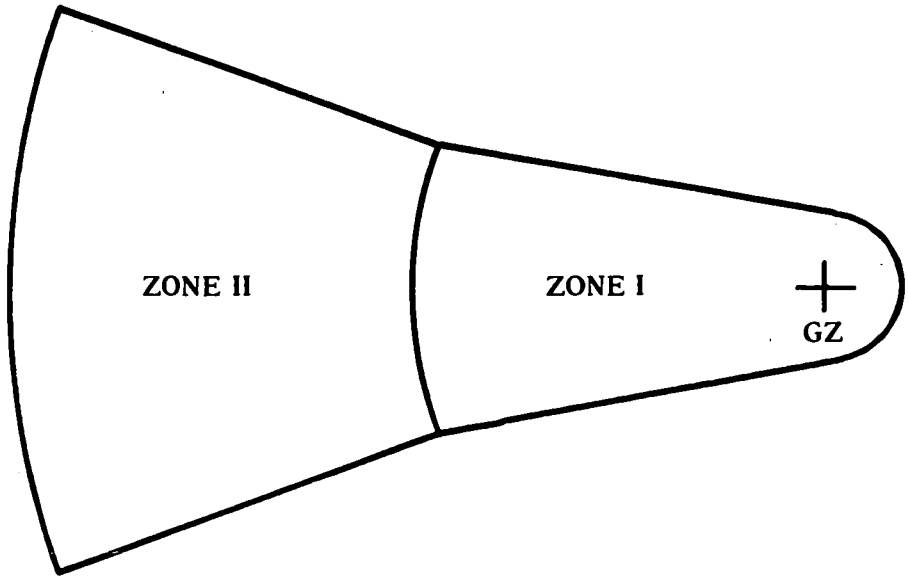


Figure 1. Zones I and II.

ard. It is defined as a zone within which the total dose received by exposed, unprotected personnel is not expected to reach 150 rad within a period of 4 hours after the actual arrival of fallout, but within which personnel may receive a total dose of 50 rad (the negligible risk dose), or greater, within the first 24 hours after the arrival of fallout. However, only a small percentage of the personnel in the zone are expected to receive these doses. The exact dose personnel will receive at any location within Zone II is dependent upon the dose rate at their location, the time of exposure, and protection available. Personnel located close to the extent of Zone I will normally receive higher doses than those located close to the extent of Zone II. Personnel with no previous radiation exposure may be permitted to continue critical missions for as long as 4 hours *after* the actual arrival of fallout without incurring the emergency risk dose. If personnel in this zone have previously received significant radiation doses (a cumulative dose of 150 rad or more), serious disruption of unit mission and casualty-producing doses may be expected.

b. Outside the Predicted Area. Outside the predicted area, exposed, unprotected personnel may receive a total dose that does not reach 50 rad in the first day (24 hours) after actual arrival of fallout. The total dose for an infinite time of stay outside the predicted area should not reach 150 rad. Therefore, outside the predicted area, no serious disruption of military operations is expected to occur if personnel have not previously been exposed to nuclear radiation. Appreciable previous exposure should be considered. In either case, periodic monitoring coupled with routine radiological defense measures will normally provide adequate protection.

c. Reliability. The predicted zones of fallout are larger than the actual area on the ground that will be covered by fallout. These zones represent areas of hazard, somewhere within which radioactive particles are predicted to fall. Because of uncertainties of weather and nuclear burst input data, the precise locations of fallout within the zones cannot be reliably predicted, but must be ascertained by monitoring and survey after fallout has settled. The zones, therefore, have been developed so that there is a reasonably high assurance that the expected fallout will not occur outside them. They represent an expected hazard area that can be quickly predicted immediately after receipt of actual or planned nuclear burst information.

d. Interpretation. The lines enclosing the fallout prediction are not to be construed as absolute boundaries for the occurrence of fallout. It is emphasized that as these predicted zones are approached from the outside, the likelihood of encountering hazardous fallout will increase as will the dose rates. Therefore, units should not *normally* be relocated based upon predicted fallout areas but, rather, upon actual radiological monitoring and survey information.

6. Basic Data

a. Requirement. The final location of fallout is primarily dependent on, first, the heights from which the fallout particles start their descent and, second, the wind structure between the ground and various portions of the cloud during the period of fall of these particles. The initial heights of the fallout particles are determined by the total yield of the nuclear burst. Thus, the reliability of a fallout prediction plot depends to a great extent on the accuracy and timeliness of nuclear burst information and upper air wind data.

b. Nuclear Burst Information.

(1) *Essential.* The nuclear burst information required for the preparation of any fallout prediction is—

(*a*) Location of ground zero (GZ).

(*b*) Total yield (assume yield to be all fission except for the special cases in (2) below) or nuclear burst and cloud parameters for computation of yield.

(*c*) Date-time of burst (not essential for prestrike predictions).

(*d*) Type of burst (when a fallout-producing burst is indicated, assume surface burst except for the special cases in (2) below). This information can be determined from NBC 1 and NBC 2 (Nuclear) reports (FM 3–12).

(2) *Special.* Height of burst (HOB) and fission yield/total yield (FY/TY) ratio information may be used for detailed prestrike fallout predictions prepared for friendly nuclear bursts from which fallout is expected. For detailed poststrike predictions of friendly nuclear bursts that inadvertently produce fallout, only the FY/TY ratio can be used because the height of burst cannot be measured and must be assumed to be 0 meters.

c. Sources. Nuclear burst information may be obtained from the command that directed the firing of a nuclear weapon, from the NBC 1 and NBC 2 (Nuclear) reports, or from intelligenc estimates; or it may be assumed for troop safety. The situations which require a fallout prediction to be prepared and the sources of nuclear burst information which apply to each situation are listed below.

(1) Prestrike fallout predictions for enemy nuclear bursts, which are prepared as parts of vulnerability studies, are based on assumed nuclear burst information. Intelligence estimates of enemy capabilities and observations of enemy weapons previously employed in similar situations may be used to support these assumptions.

(2) Prestrike fallout predictions prepared as part of the target analysis for friendly nuclear bursts that are not intended to produce fallout are based on planned nuclear burst information, except that the burst is assumed to be a surface burst for troop safety.

(3) Prestrike fallout predictions prepared as part of the target analysis for friendly nuclear bursts from which fallout is intended will be based on planned information. HOB and FY/TY adjustments may be used if a detailed fallout prediction is prepared.

(4) Poststrike information may indicate that fallout probably will occur or that fallout has started from a nuclear burst. Poststrike fallout predictions for friendly bursts from which fallout was not originally expected are prepared on the basis of a surface burst, using planned yield, FY/TY ratio, and ground zero as obtained from the fire support coordination facility. Actual ground zero will be used in this case if nuclear burst report data are available. The prestrike fallout prediction may be modified and used as the poststrike fallout prediction if the wind data and other information are still valid.

(5) Poststrike fallout predictions for enemy bursts are prepared on the basis of information derived from NBC 1 and NBC 2 (Nuclear) report data.

d. Upper Air Wind Data. Upper air wind data to be used in the prediction of fallout may be obtained in the field army from the US Army field artillery meteorological sections; the US Air Force Air Weather Service (AWS) detachments that support the field army may be used to augment these data. Upper air wind data may be obtained from sources other than field artillery and AWS. Guidance is provided in section I of chapter 2 for using upper air wind data from the US Army field artillery, Air Weather Service, US Weather Bureau, and other weather services.

7. Training

a. Individual Training. Unit commanders will insure that selected individuals are trained in the construction and use of a simplified fallout predictor and in the preparation of the fallout prediction plot from the fallout prediction message (NBC 3 (Nuclear) report). In addition, all individuals will be trained to such a level that they will have a basic understanding of the radiation hazards from fallout and the measures which provide protection against it. Appropriate service schools

will train personnel in the use of the effective downwind message, the M5A2 fallout predictor, and the NBC 3 (Nuclear) report in preparing a simplified or detailed fallout prediction.

b. Unit Training. Fallout situations will be integrated into unit training exercises. Standing operating procedures will contain adequate instructions to be taken when units are alerted to expected contamination (based on the fallout prediction). Unit commanders and staff officers will consider current fallout predictions in tactical operations; when making tactical plans; and in training exercises, command post exercises, and maneuvers.

CHAPTER 2

DETAILED FALLOUT PREDICTION (STANAG 2103, ABCA QSTAG 123)

Section I. FALLOUT WIND VECTOR PLOT

8. Significance of the Fallout Wind Vector Plot

The wind vector plot is used to determine the lateral limits of fallout, the effective downwind direction, and the effective wind speed. This plot is prepared by the CBRE on receipt of new upper air wind data. It is prepared on overlay paper, oriented to grid north, and drawn to a convenient scale. The plot consists of a series of vectors representing wind layers between the surface of the earth and the height to which upper air wind data are obtained. The vectors are plotted head to tail, and each vector represents the distance and direction a nominal size particle would travel over the earth while falling through the wind layer. The nominal size particle is defined to be of such size (a spherical particle 143 microns in diameter) as to require 3 hours to fall from a height of 11,000 meters to the ground. The significance of the wind vector plot is that after it is oriented by the GZ tickmark and grid north, it represents a series of points on the ground where the nominal size particles are expected to land. That is, a nominal size particle starting its downwind drift (fall) from a height of 30,000 meters is expected to land on the ground at the point represented by 30,000 meters on the wind vector plot. Similarly, a nominal size particle starting at 29,000 meters is expected to land on the ground at a point halfway between 28,000 meters and 30,000 meters on the wind vector plot. Further, a line drawn from GZ through a particular height point on the wind vector plot represents the locus of points on which all fallout particles from that particular height are expected to land. Heavier particles will land closer to ground zero than will the lighter ones, but all the particles starting from that particular height are expected to land along his line. The plot is available at the CBRE and is ready for use when a fallout-producing nuclear burst occurs. A completed fallout wind vector plot for a particular set of upper air wind data is shown in figure 8(4).

9. Upper Air Wind Data

a. Upper air wind data for fallout prediction by tactical units are normally obtained from division or corps field artillery meteorological sections. These sections forward meteorological information to fire direction centers (FDC) and to appropriate fire support coordination facilities (FSCC/FSE), using the procedures and format established by FM 6–15 and summarized in *b* below.

b. The network of field artillery meteorological sections in the corps sector provides all FDC and FSCC/FSE within the corps with the upper air wind data in (2) below to the heights and on the schedules indicated.

(1) Heights and schedules are:

(*a*) To 30,000 meters or to the bursting height of the balloon, whichever comes first, four times daily at 0600, 1200, 1800, and 2400 hours Greenwich Mean Time (GMT). Minimum acceptable height is 24,000 meters.

(*b*) To 18,000 meters eight times daily at 0200, 0400, 0800, 1,000, 1400, 1600, 2000, and 2200 hours GMT. Minimum acceptable height is 14,000 meters.

(2) Data provided are:

(*a*) Average wind speed in knots for each 2,000-meter layer above the mean datum plane of the reporting meteorological section.

(*b*) Wind direction to the nearest 10 mils *from* which the winds in (*a*) above are blowing.

Note. Special data at significant levels (pressures, temperatures, and relative humidities) will be furnished only when specifically requested. A significant level is defined as any level in the atmosphere where a significant weather change occurs.

c. The data listed above are transmitted to the CBRE by means of established communication

nets. Division and Army FSCC/FSE monitor this net to obtain data directly. The FSCC/FSE relays the upper air wind data to the CBRE.

d. Upper air wind data for fallout prediction where US Army field artillery wind observations are not available may be obtained from other sources. These upper air wind data must provide wind speeds and directions for consecutive wind layers above the observing station or altitude layers above mean sea level. For example, wind direction to the nearest 10 degrees from true north and wind speed to the nearest knot may be obtained from AWS detachments within the field army. The primary source for upper air wind data in the continental United States is the US Weather Bureau, which reports wind direction to the nearest 10 degrees and wind speed to the nearest knot. Wind direction is the direction *from* which the wind is blowing. Upper air wind observations are transmitted over various Federal Aviation Agency (FAA) and military weather communications circuits in a standard upper air wind code agreed upon internationally through the World Meteorological Organization. Decoding procedure is given in TM 1–300. If current wind data are not given to the required height, the latest available data from previous reports for the higher levels are used to extend the plot. Up-to-date wind data that have been obtained from a source as close as possible to the actual or expected ground zero should be used.

e. US Army field artillery upper air wind data are preferable to wind data from other sources when the field artillery data are obtained from an observation point not more than one and one-half times as far from the actual or expected ground zero as the data from other sources are from ground zero. Data from other sources, which report wind direction, speed, and height in units other than mils, knots, and kilometers, may be converted by using tables 1 and 2 (found in chapter 6).

10. Preparation of the Fallout Wind Vector Plot

a. In preparing the fallout wind vector plot, successive vectors for each wind layer are laid off from the downwind end of the preceding vector, starting with the lowest height level and working upward. The direction of each vector is the same as the wind direction for that layer; the length of the vector is the product of the wind speed and a weighting factor. The weighting factor represents the time a nominal size fallout particle will spend in the altitude layer of interest multiplied by the appropriate distance conversion factor. The weighting factor is multiplied by the wind speed in knots so that the vector length is in kilometers. The end of each vector is labeled with the height of the top of the layer it represents, and other identifying data are added (para 14).

b. Tables and figures containing wind weighting factors are provided in chapter 6.

c. Example problem 2 (para 23) illustrates the preparation of a fallout wind vector plot from US Army field artillery upper air wind data.

11. Fallout Prediction Plotting Scale

a. As illustrated in example problem 2 (para 23), several steps are involved in plotting each wind vector. This plotting is facilitated by the use of a plotting scale to reduce the number of steps involved. Some of the operations that are eliminated are the conversion of the direction *from* which the winds are blowing to the direction *toward* which the winds are blowing and the calculation of the vector length. The ML–556/UM fallout prediction plotting scale, illustrated in figure 2, permits plotting of the wind vectors directly from field artillery or Air Weather Service upper air wind data. The plotting scale is constructed of clear plastic and consists of two main parts:

(1) An azimuth dial with an inner scale in degrees and an outer scale in hundreds of mils.

(2) A series of 11 slots representing various wind layers (altitude zones) with wind speeds graduated in knots along each slot for use with three different map scales. The weighting factors in table 3 (chap 6) have been used to convert wind speeds in knots (nautical miles per hour) to vector lengths in kilometers.

b. Plotting field artillery upper air wind data with the plotting scale is accomplished as follows:

(1) Attach overlay paper to a piece of graph paper, a map, a firing chart, or any other paper with parallel lines that can serve as north-south grid lines. Mark GZ, scale, and grid north on the overlay paper.

(2) Lay the plotting scale on the chart so that the hole at the end of the slot labeled "0–2" lies over the starting point (GZ).

(3) Secure the scale to the chart by inserting a sharpened instrument (hard lead pencil or a pin) through the hole, and rotate the scale so

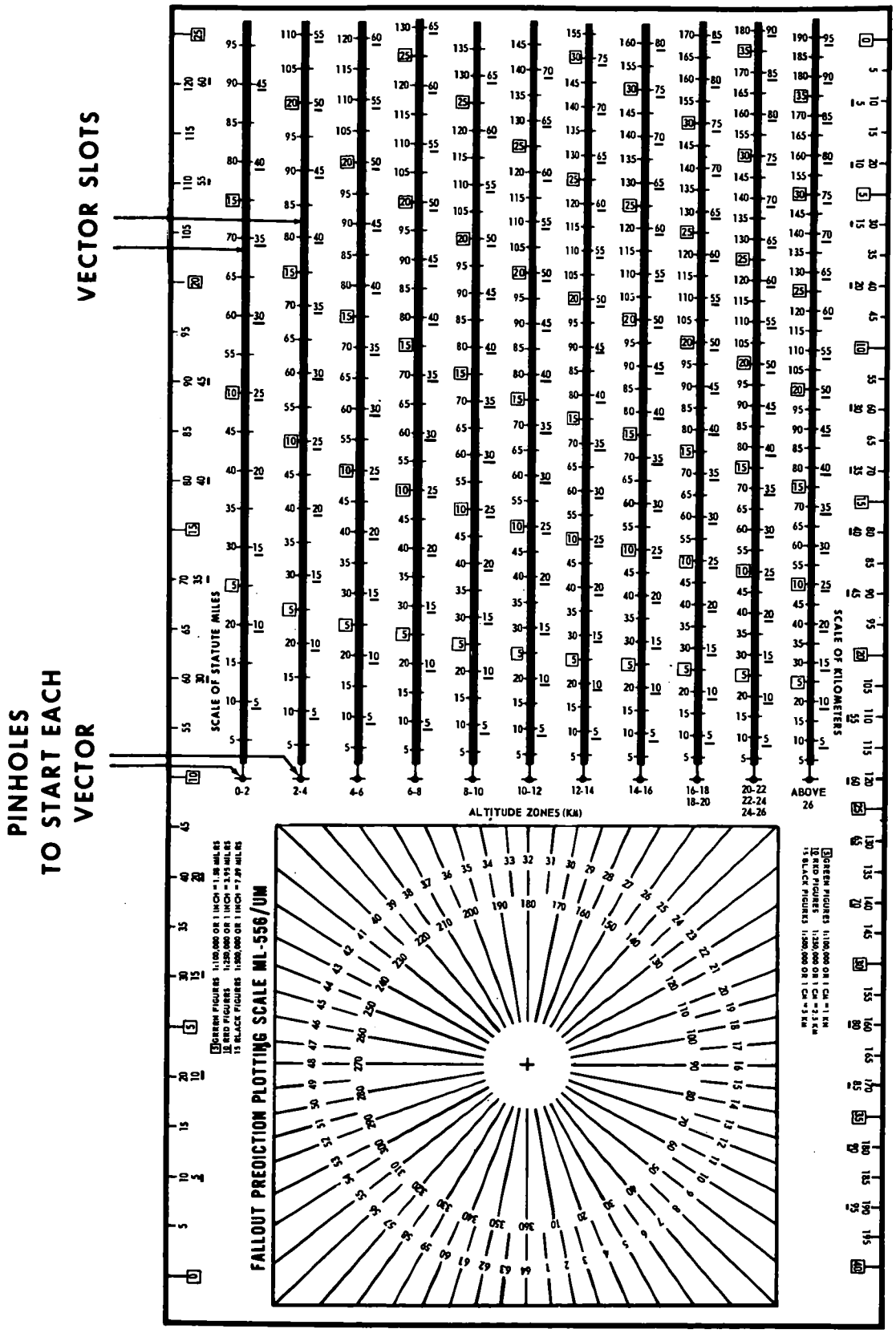


Figure 2. Fallout prediction plotting scale.

that the line on the azimuth dial representing the wind direction for the lowest (0- to 2,000-meter) wind layer is parallel to the north-south grid lines and is oriented with the azimuth representing the wind direction pointing north. Note that the wind direction in this case is the wind direction as read directly from the field artillery upper air wind data.

(4) Hold the scale firmly and using the "0–2" slot, draw a line to the point which represents the wind speed in knots for the 0- to 2,000-meter layer as read directly from the field artillery upper air wind data. This point will be determined by using the map scale selected (indicated by the color legend from the plotting scale). Lift the scale and mark this point with the number 2 (to indicate the top of the layer it represents).

(5) Next, move the scale so that the hole at the end of the slot labeled "2–4" lies over the outer end of the wind vector just plotted. Orient the scale in the manner described in (3) above; however, this time use the wind direction for the 2,000- to 4,000-meter layer. Using the "2–4" slot, draw a line to the point representing the wind speed in the 2,000- to 4,000-meter layer. Lift the scale and mark this point with the number 4.

(6) Repeat this procedure for each wind layer until the plot is completed. Be sure to use the appropriate slot for each wind layer being plotted. Note that starting with the "16–18" slot, each slot is used to plot several vectors.

(7) Example problem 3 (para 24) illustrates the preparation of a wind vector plot, using the plotting scale and US Army field artillery upper air wind data.

c. Plotting AWS upper air wind data with the plotting scale is accomplished in much the same manner as for field artillery upper air wind data, except that different slots are used for the wind layers; for heights above 45,000 feet, the vector is drawn to a point on the slot scale equal to *one-half of the reported wind speed.* Table 4 (chap 6) provides weighting factors and plotting scale data to be used with AWS wind data. Example problem 4 (para 25) illustrates the use of the plotting scale with AWS upper air wind data.

d. The scale, plotting, fallout prediction, ML–556/UM, is requisitioned through supply channels using FSN 6675–868–8094.

12. AWS Constant Pressure Surface (Isobaric) Wind Data

a. The AWS detachments attached to major command headquarters within the field army have the capability of providing estimates of the wind structure, using constant pressure surface charts. When local upper air wind data are not available, the wind structure determined from constant pressure surface charts may be used to prepare a local fallout wind vector plot. In addition to supplementing local field artillery and AWS wind measurement capabilities, the constant pressure surface charts can be used for two special purposes:

(1) Inasmuch as they cover very large areas, they may be used to obtain upper air wind data for fallout prediction at *distant locations.*

(2) They may also be used to forecast wind speeds and directions used for fallout predictions for periods from *24 to 48 hours.*

b. A constant pressure surface chart depicts the altitude at any location at which a specific pressure surface will be found. From these constant pressure surface charts, the wind directions and speeds can be obtained for various altitudes. The following constant pressure surfaces above mean sea level are used for this purpose:

Constant pressure surface (millibars)	*Average altitude (feet)*
850	5,000
700	10,000
600	14,000
500	18,000
400	24,000
300	30,000
200	39,000
150	45,000
100	53,000

The wind directions obtained are reported in degrees *from* which the winds are blowing, and the wind speeds are reported in knots. Weighting factors and plotting scale data required for preparation of the fallout wind vector plot from AWS isobaric wind data are contained in table 5 (chap 6).

c. Example problem 5 (para 26) illustrates the use of the plotting scale with AWS isobaric wind data.

13. Other Wind Reporting Systems

a. In the event that upper air wind data are not available from any of the wind reporting systems mentioned in this section, other types of wind data may have to be used. Under these circumstances the fallout wind vector plot will be prepared by converting the units of reported data and following the procedure established by example problem 2 (para 23). In this case, weighting

factors will be determined from time-of-fall data from figure 29 (chap 6).

b. Example problem 6 (para 27) illustrates the conversion and weighting factor problems of preparing a fallout wind vector plot from data available from other wind reporting systems.

14. Minimum Required Information for Fallout Wind Vector Plot

a. Regardless of the procedures applied, the resulting wind vector plot must contain the following *minimum* information:

(1) A labeled GZ point.

(2) The plot of vectors for each wind layer, starting from the surface and proceeding upward consecutively to the highest observed wind level. Each vector must represent the distance in kilometers and direction that a nominal size particle would travel over the surface while falling through the layer.

(3) Identification of each wind layer by designating the height levels, in thousands of feet or meters, of the top and bottom of the wind layer on the vector plot.

(4) Scale of the wind vector plot.

(5) A grid north line.

b. The fallout wind vector plot may show the wind data source and the time and location at which the wind data are obtained.

Section II. Detailed FALLOUT PREDICTION—GENERAL PROCEDURE

15. Description

a. The detailed fallout prediction is normally prepared by the CBRE. It is based on NBC 2 (Nuclear) reports (evaluated data), or target analysis information, and upper air wind data (para 6). The upper air wind data are rapidly processed into a fallout wind vector plot each time they are received. With a current wind vector plot, the CBRE can have a detailed fallout prediction ready for dissemination in a matter of minutes after required nuclear burst information is available.

b. The completed prediction consists of two zones of hazard as described in paragraph 5. The detailed prediction is illustrated in figure 3 and is delineated by the following:

(1) Identification of grid north (GN), map scale, GZ coordinates, and date-time of burst.

(2) Two radial lines, drawn from the ground zero point at azimuths determined from the wind vector plot and radioactive cloud and stem parameters, dependent on yield.

(3) Two downwind arcs, representing the downwind distances of Zone I and Zone II.

(4) A circle drawn around GZ with a radius equal to the stabilized cloud radius.

(5) Two tangents drawn from the ground zero circle to the points of intersection of the two radial lines with the Zone I arc.

(6) One or more time-of-arrival arcs (dashed), representing the expected time of arrival of fallout as it moves downwind from ground zero. Only those time-of-arrival arcs that are located within the zones are normally indicated on the fallout prediction.

c. Procedures employed by the CBRE in the preparation of the detailed prediction are presented in section III of this chapter.

d. The CBRE will prepare the detailed fallout prediction plot overlay for use within the tactical operations center (TOC) and elsewhere, as required. The detailed fallout prediction plot may be disseminated as an NBC 3 (Nuclear) report (para 16) to other staff agencies both within and outside the TOC and to higher, adjacent, and subordinate units, as appropriate, and as indicated in the SOP.

16. NBC 3 (Nuclear) Report

a. The detailed fallout prediction is disseminated in the form of a fallout prediction message, the NBC 3 (Nuclear) report, standardized by Standardization Agreement (STANAG) 2103. This message is used to issue an immediate warning of expected contamination resulting from a nuclear detonation. (Letter items prescribed for NBC reporting other than those shown in the example below may be added at the user's discretion.) The format for the report will be a series of letter items, preceded by the phrase "NBC 3 (Nuclear)," as follows:

	NBC 3 (Nuclear)
ALFA	Strike Serial Number (if known)
DELTA	DDtttt (local or ZULU, state which; only ZULU times will be used by NATO forces)
FOXTROT	yyzzzzzz (actual or estimated, state which)
YANKEE	ddddcccc (mils or degrees, state which)
ZULU	sssxxxrr

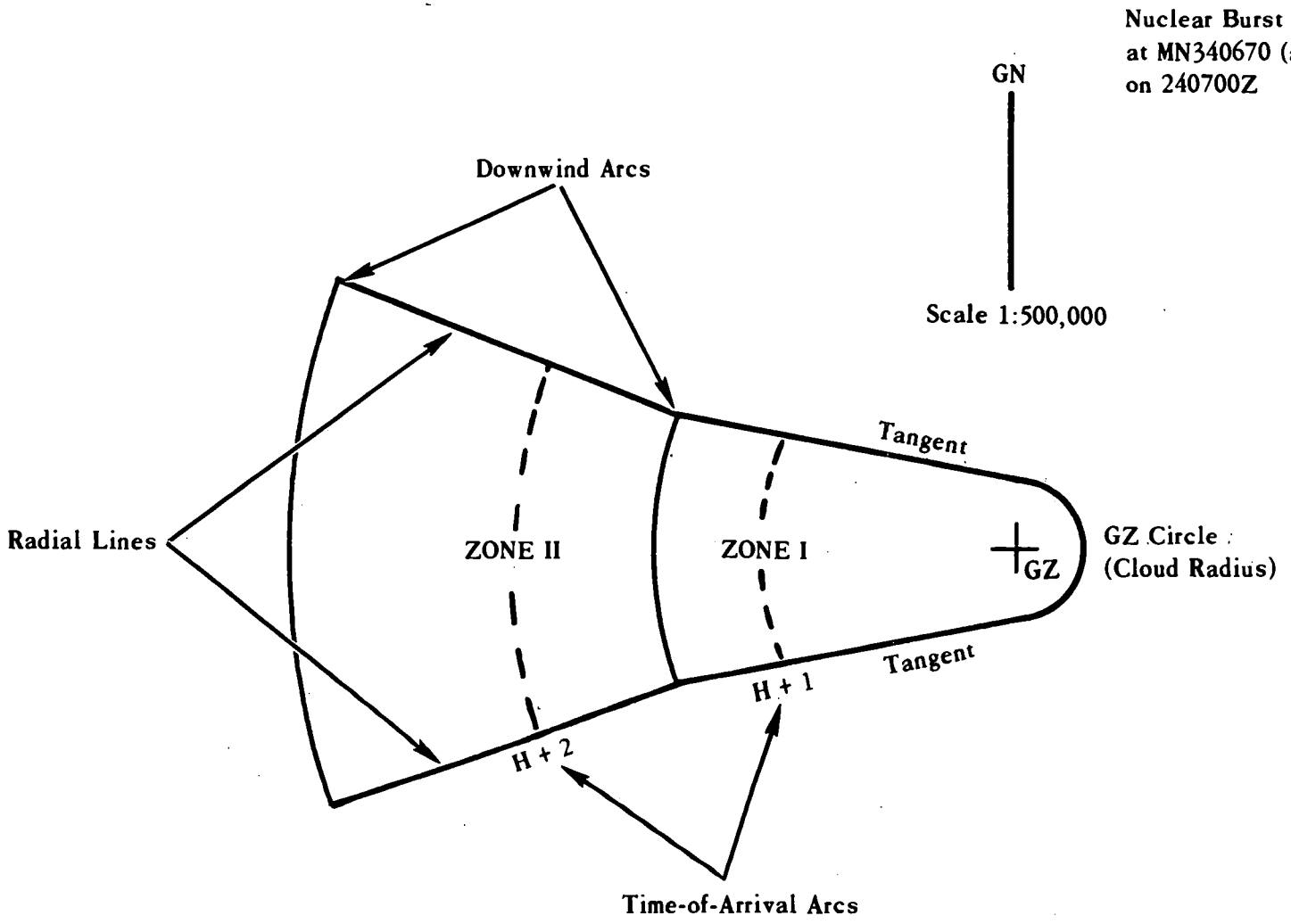


Figure 3. Detailed fallout prediction (designation of parts).

b. The significance of each letter item is indicated below:

(1) ALFA—This line is the strike serial number (if known). The strike serial number will be assigned by the CBRE at the operations center responsible for the area in which the strike occurs.

(2) DELTA DDtttt—This line is the date-time group of the burst, with DD the day and tttt H-hour in local or ZULU time (GMT), state which.

(3) FOXTROT yyzzzzzz—This line provides the actual or estimated (state which) coordinates of ground zero, with yy the two letters representing the appropriate 100,000-meter grid square and zzzzzz the coordinates of ground zero within this grid square.

(4) YANKEE ddddcccc—This line provides the azimuths of the two radial lines to the nearest mil or degree from grid north, with dddd the azimuth of the left radial line and cccc the azimuth of the right radial line. Left and right in this case are those angles as they would appear to an observer located at ground zero looking downwind. The unit of measurement (mils or degrees) of the azimuths must be indicated. (This line is omitted when the special case applies (para 17*d* and 21).)

(5) ZULU sssxxxrr—This line provids prediction dimensions, with sss the effective wind speed to the nearest kilometer per hour (kmph), xxx the downwind distance of Zone I to the nearest kilometer (km), and rr the radius of the stabilized cloud (GZ circle) to the next higher kilometer if the value is not a whole number. (This line contains only three digits when the special case applies (para 17*d* and 21).)

17. Use of the NBC 3 (Nuclear) Report

a. Prediction Plot. Upon receipt of an NBC 3 (Nuclear) report, the recipient will prepare a fallout prediction plot on a piece of overlay paper or other transparent material by using the following procedures:

(1) Identify the prediction by marking and labeling some point as GZ, drawing and labeling a grid north line, writing in the map scale and date-time of the burst (DELTA DDtttt), and referencing the overlay with GZ coordinates (FOXTROT yyzzzzzz) or index points.

(2) From the ground zero point, draw the left (YANKEE dddd and right (YANKEE cccc) radial lines at the proper azimuths from the grid north line.

(3) Draw an arc between the two radial lines with a radius equal to the downwind distance of Zone I (ZULU xxx), using GZ as center. Draw a second arc between the radial lines at twice this radius for the downwind distance of Zone II.

(4) Draw a circle around ground zero with a radius equal to the radius of the stabilized cloud (ZULU rr).

(5) Draw tangents from the outer edge of the ground zero circle to the points of intersection of the radial lines with the Zone I arc.

(6) Draw as many dashed time-of-arrival arcs between the radial lines or tangent lines as will fall within the zones. Additional time-of-arrival arcs may be added if the user so desires. Label each time-of-arrival arc as hours after H-hour. Times of arrival are estimated by using the effective wind speed (ZULU sss) as indicated in *b* below. If a time-of-arrival arc coincides with a zone boundary, extend the zone boundary with a dashed line and label with the appropriate time of arrival.

b. Times of Arrival.

(1) The downwind distances to which fallout will extend in specified periods of time can be estimated by multiplying the effective wind speed by the time of interest expressed in hours after the burst. Time-of-arrival arcs representing the expected downwind extent of fallout at any time of interest can then be drawn as part of the fallout prediction. Time of arrival of fallout at a specific distance from ground zero can be *estimated* by dividing that distance by the effective wind speed.

$$\text{Time of arrival (hr)} = \frac{\text{distance from GZ (km)}}{\text{effective wind speed (kmph)}}$$

(2) For operational purposes, the following rules of thumb may be applied to the actual arrival of fallout:

(*a*) The actual arrival of fallout may occur as early as one-half the estimated time of arrival. That is, if the estimated time of arrival of fallout is H + 4 hours, actual arrival of fallout may occur as early as H + 2 hours.

(*b*) If actual arrival of fallout has not occurred at twice the estimated arrival time, or 12 hours, whichever is earlier, then it may be assumed that the area will not receive fallout. That is, if the estimated time of arrival of fallout in

an area is H + 4 hours and fallout has not occurred at H + 8 hours, then it may be assumed that the area will not receive fallout.

c. Orientation. With the fallout prediction completed, orient the overlay on the operations map and estimate the operational impact. To orient the fallout prediction, place GZ of the plot on the map at the coordinates of the actual or assumed GZ, with the GN line pointing toward the grid north.

d. Special Case. When the effective wind speed is less than 8 kilometers per hour, refer to paragraph 21.

e. Example. Example problem 1 (para 22) illustrates the preparation of a detailed fallout prediction from the NBC 3 (Nuclear) report.

Section III. DETAILED FALLOUT PREDICTION TECHNIQUES

18. General Procedure

The detailed fallout prediction is prepared by the CBRE in the following sequence.

a. Step 1. Prepare the fallout wind vector plot.

b. Step 2. Determine nuclear burst input data.

c. Step 3. Determine cloud parameters.

d. Step 4. Determine lateral limits of fallout and expand, if necessary.

e. Step 5. Determine effective wind speed.

f. Step 6. Determine downwind distances of Zones I and II.

g. Step 7. Construct the left and right radial lines.

h. Step 8. Complete the fallout prediction. The nomograms used to prepare the detailed fallout prediction are grouped together in chapter 6.

i. Step 9. Prepare the fallout prediction message (NBC 3 (Nuclear) report) and applicable overlays.

19. Detailed Procedure

a. Step 1. Preparation of Fallout Wind Vector Plot. Prepare the fallout wind vector plot as described in section I of this chapter. The fallout wind vector plot is prepared each time new upper air wind data are received; every prediction made from the current fallout wind vector plot should be prepared on a separate overlay so that the current fallout wind vector plot may be saved for further use. The fallout wind vector plot may be drawn to any convenient map scale.

b. Step 2. Determination of Nuclear Burst Information (para 6*b*). A convenient worksheet for recording data for the detailed fallout prediction method is shown in figure 4. This worksheet may be reproduced locally. Nuclear burst information is recorded on lines a through e.

c. Step 3. Determination of Cloud Parameters. Cloud parameters are read from figure 30. Enter figure 30 with the yield by placing a straightedge so that the values on the left yield index scale and on the right yield index scale are the same. Read all parameters under the straightedge. Cloud parameter values are recorded on lines f through j of the worksheet.

d. Step 4. Initial Determination of Lateral Limits of the Fallout Prediction. Mark points representing the cloud-top height, cloud-bottom height, and two-thirds stem height on the fallout wind vector plot; and draw radial lines from the ground zero point through these height points (interpolate linearly between the wind vectors if necessary) (fig 11(1)). Disregard all wind vectors below the two-thirds stem height point and above the cloud-top height point for the prediction being prepared. If wind vectors *between* the two-thirds stem height point and the cloud-top height point fall outside the radial lines drawn from ground zero through these points, expand the angle formed by these two radial lines to include these outside wind vectors. (An example of this procedure is shown in fig 11(9)).

e. Step 5. Determination of the Effective Wind Speed. Measure the length of the radial line, in kilometers, from GZ to the cloud-bottom height point (fig. 11(2)). Record this value on line k of the worksheet. Read the time of fall from the cloud bottom (determined in step 3), from the worksheet (fig. 4, item j). Compute the effective wind speed as shown below and record on line 1 of the worksheet.

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

a. Time of Burst (date-time group) _____ DELTA DDtttt (local or ZULU)

b. GZ Coordinates _____ FOXTROT yyzzzzzz (actual or estimated)

c. FY/TY Ratio (from target analyst for friendly weapons only) _____

d. HOB (from target analyst for friendly weapons only) _____ meters

e. Yield _____ KT or MT

f. Cloud-top Height (fig. 30) _____ 10^3 meters or feet

g. Cloud-bottom Height (fig. 30) _____ 10^3 meters or feet

h. 2/3 Stem Height (fig. 30) _____ 10^3 meters or feet

i. Stabilized Cloud Radius (fig. 30) _____ ZULU rr (km)

j. Time of Fall from Cloud Bottom (fig. 30) _____ hours

Fallout Wind Vector Plot (Enter f, g, and h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height.)

k. Radial Line Distance from GZ to Cloud-bottom Height _____ km

l. Effective Wind Speed = $\frac{k\ (GZ\text{-}CB\ dist)}{j\ (Time\ of\ fall)}$ = _____ $\frac{km}{hr}$ = _____ ZULU sss (kmph)

m. Downwind Distance of Zone I (Enter fig. 31 with l and e.) _____ km

n. Adjustment = FY/TY Factor _____ (Enter fig. 34 with e and c or use one.) × HOB Factor _____ (Enter fig. 32 or 33 with d and e or use one.) = _____

o. Adjusted Downwind Distance of Zone I (m × n) _____ ZULU xxx (km)

Fallout Wind Vector Plot (Check lateral limits for 40 degrees.)

p. Azimuth of Left Radial Line _____ YANKEE dddd (mils or degrees)

q. Azimuth of Right Radial Line _____ YANKEE cccc (mils or degrees)

r. NBC 3 (Nuclear)

ALFA	AAA	____ ____	(strike serial number)
DELTA	DDtttt	____ ____ ____ ____ ____ ____	(local or ZULU)
FOXTROT	yyzzzzzz	____ ____ ____ ____ ____ ____ ____ ____	(GZ coordinates–actual or estimated)
YANKEE	ddddcccc	____ ____ ____ ____ ____ ____ ____ ____	(azimuths of radial lines–mils or degrees)
ZULU	sssxxxrr	____ ____ ____ ____ ____ ____ ____ ____	
		(effective wind speed) (downwind distance) (cloud radius)	

Figure 4. Detailed fallout prediction worksheet.

f. Step 6. Determination of the Downwind Distances of Zones I and II.

(1) Using figure 31 aline a straightedge from the yield on the right-hand scale to the value of the effective wind speed on the left-hand scale; at the intersection of the straightedge with the center scale read the value of the downwind distance of the Zone of Immediate Operational Concern (Zone I) for a surface burst. Record this value on line m of the worksheet.

(2) If FY/TY ratio is known, obtain the FY/TY adjustment factor from figure 34. Lay a straightedge from the total yield on the left-hand scale to the value of the FY/TY ratio on the right-hand scale; at the intersection of the straightedge with the center scale, read the FY/TY adjustment factor. If the FY/TY ratio is not known, assume the yield to be 100 percent fission and use an FY/TY adjustment factor of 1. Record the FY/TY adjustment factor on line n of the worksheet.

(3) If the height of burst is known (as in the case of a prestrike friendly burst), obtain the height of burst adjustment factor from figure 32 for yields equal to or less than 100 KT or from figure 33 for yields greater than 100 KT. Lay a straightedge from the yield on the left-hand scale to the value of the height of burst on the center scale; at the intersection of the straightedge with the right-hand scale, read the height of burst adjustment factor. If height of burst is not known, assume a zero height of burst and use a height of burst adjustment factor of 1. Record on line n of the worksheet.

(4) Multiply the Zone I downwind distance for a surface burst, determined in (1) above, by both the height of burst adjustment factor and the FY/TY adjustment factor to obtain the adjusted downwind distance of Zone I for the given conditions. Record this value on line o of the worksheet.

(5) Double the distance found in (4) above to obtain the adjusted downwind distance of the Zone of Secondary Hazard (Zone II).

g. Step 7. Construction of the Left and Right Radial Lines.

(1) Measure the angle formed by the radial lines drawn from ground zero to the cloud-top height and two-thirds stem height points on the fallout vector plot (or the radial lines which have been expanded to include vectors between the two-thirds stem height and the cloud-top height). If the angle formed is 40 degrees or greater, proceed as outlined in (2) below. If the angle formed is less than 40 degrees, bisect the angle and expand the angle formed by the two radial lines to 40 degrees (20 degrees on each side of the bisector) (fig 11(3)).

(2) Measure the azimuths, in mils or degrees from grid north, of the final left and right radial lines and record on lines p and q of the worksheet (use four digits).

h. Step 8. Completion of the Fallout Prediction.

(1) Start with GZ on an overlay at the selected map scale, and extend the radial lines at their proper azimuths to any convenient distance. Mark grid north on this overlay. (The fallout wind vector plot was originally drawn to a convenient map scale; for example, 1:500,000. If it is more convenient, a different map scale can now be used to complete the fallout prediction.)

(2) Between the two radial lines drawn from ground zero, and using ground zero as center, draw two arcs with radii equal to the Zone I and Zone II downwind distances found in step 6.

(3) Using ground zero as center, draw a circle around ground zero with a radius equal to the cloud radius at the selected map scale (fig 11(5)).

(4) Draw two tangents extending from the ground zero circle to the points of intersection of the two radial lines with the Zone I arc (fig 11 (6)).

(5) Using ground zero as center, indicate the estimated times of arrival of fallout by drawing dashed arcs downwind at distances equal to the product of the effective wind speed and each hour of interest (fig 11(7)).

i. Step 9. Preparation and Dissemination of the Detailed Fallout Prediction Message (NBC 3 (Nuclear) Report).

(1) Complete line r (the NBC 3 (Nuclear) report) of the worksheet.

(2) Prepare the report, using the format in paragraph 16. Data entered in the ZULU line of the NBC 3 (Nuclear) report (fig 4, line r) are rounded as outlined in (*a*) and (*b*) below.

(*a*) The effective wind speed (sss) is rounded off to the nearest kilometer per hour. The downwind distance of Zone I (xxx) is rounded off to the nearest kilometer.

(*b*) The cloud radius (rr) is rounded up

to the next kilometer if the value is not a whole number. (For example, 5.1 is rounded to 6.0.)

(3) Disseminate the report in accordance with unit SOP.

j. Example. Example problem 7 (para 28) illustrates the preparation of a detailed fallout prediction.

Section IV. SPECIAL FALLOUT PREDICTION CASES

20. Overlapping Contamination

a. It is probable under nuclear warfare conditions that there will be occasions when a fallout prediction will overlap an area in which contamination already exists. Similarly, there will be cases when fallout predictions will overlap each other; for example, two fallout-producing bursts which occur within a few hours of each other where one was upwind from the other.

b. Use the following rule for determining the

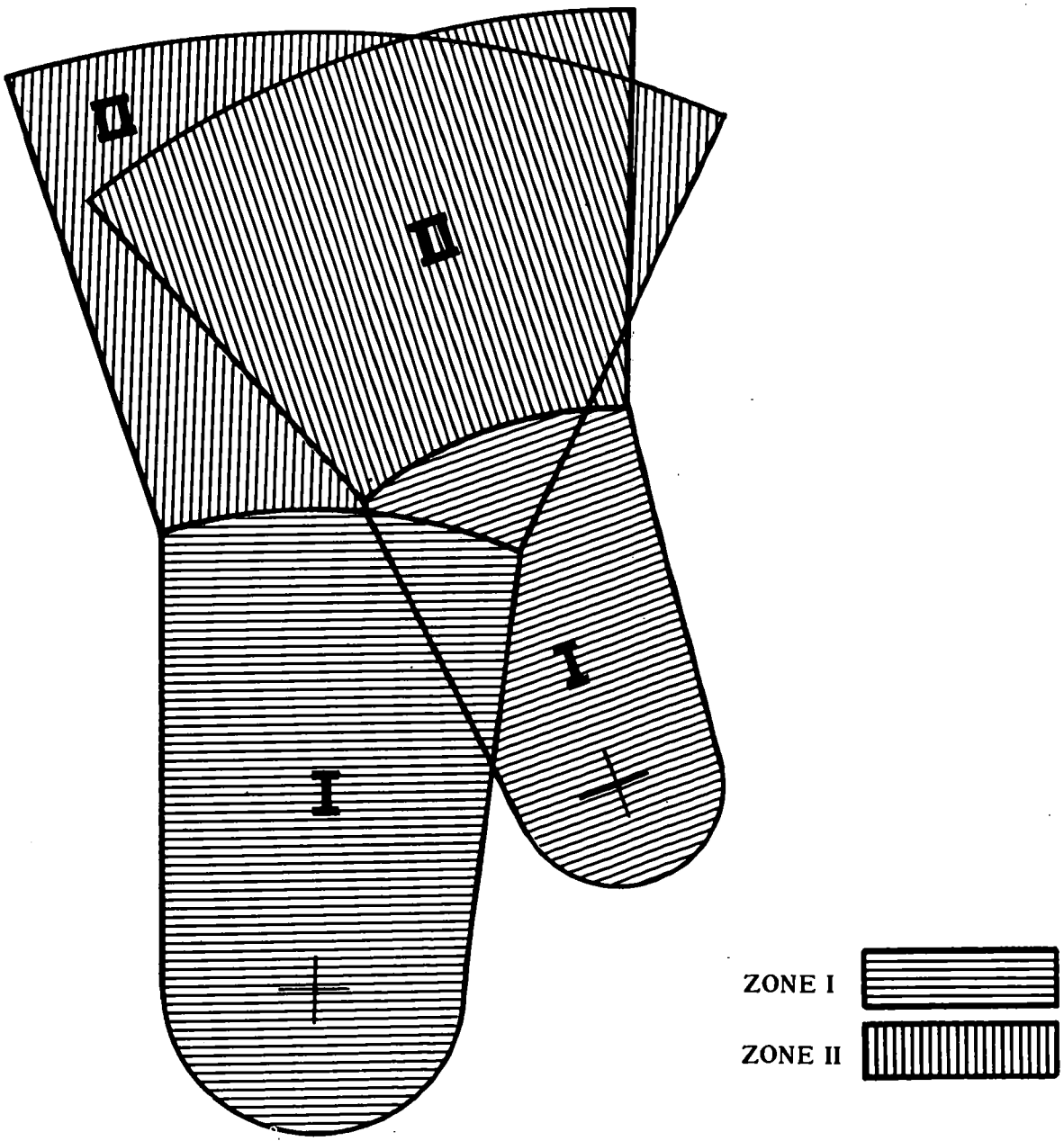


Figure 5. Overlapping fallout predictions.

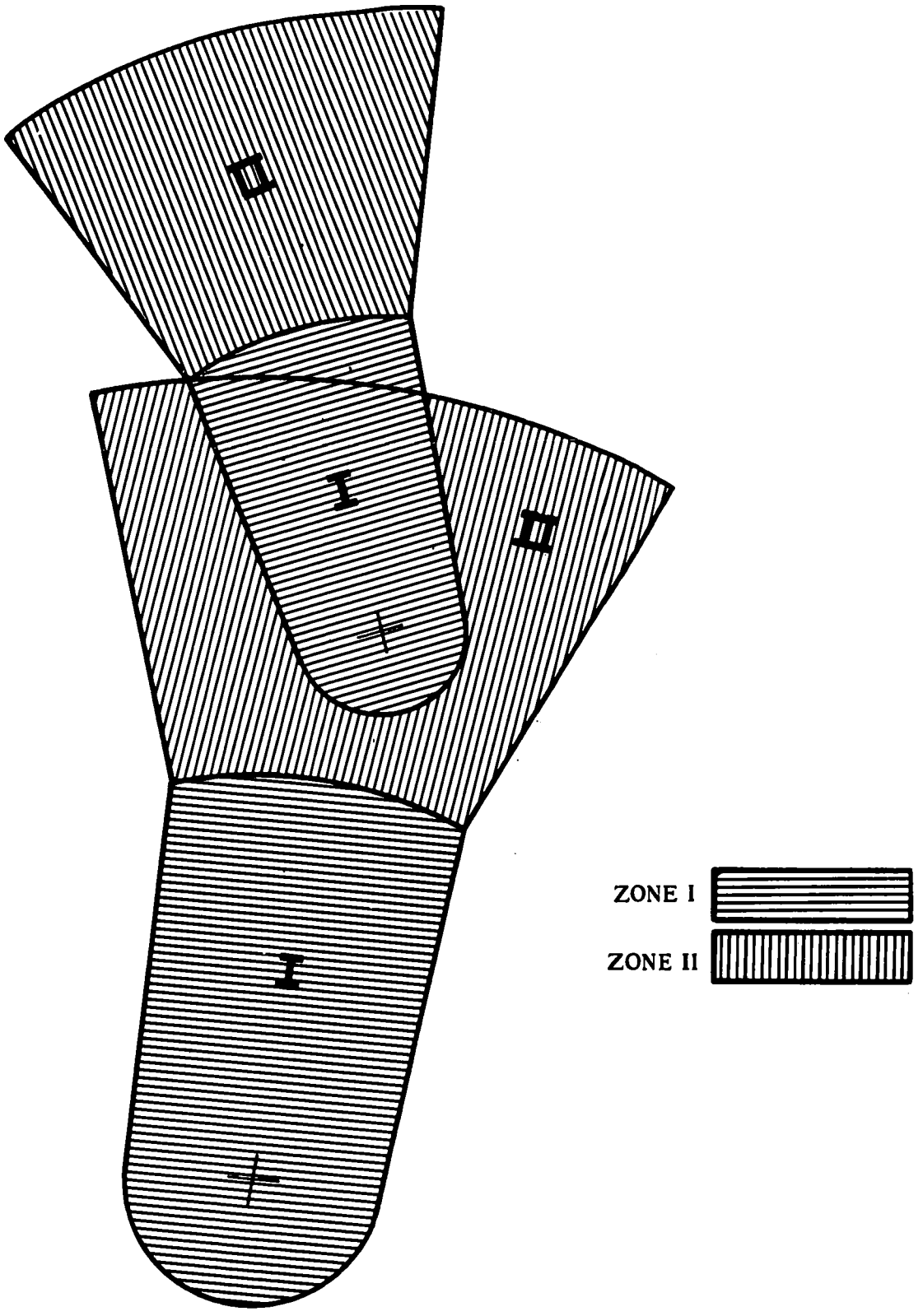


Figure 6. Multiple prediction pattern for two bursts where GZ of the first burst is in Zone II of the second burst.

relative hazard when two or more fallout *predictions* overlap: *The hazard classification of an area where predicted fallout hazard zones overlap should be only that of the higher classification involved.* That is, an overlap area involving Zone I should be designated Zone I, and an overlap area involving nothing more hazardous than Zone II should be designated Zone II. For examples of the rule, see figures 5 and 6.

c. The above rule is useful only for a matter of several hours after the bursts. The extent of contamination should be determined as soon as possible from monitoring and survey reports. When bursts are separated by several hours, the pattern already on the ground must be considered in conjunction with the fallout prediction for the later burst.

21. Very Low Winds

a. The situation may arise when the effective wind speed cannot be reliably defined for a particular yield; i.e., when the effective wind speed drops below 8 kilometers per hour. When this occurs, the winds are either light and variable or are constantly changing direction, or both. In such cases, fallout may occur at almost any location around ground zero, nad the predicted area of hazard will be a circle around ground zero. To prepare a fallout prediction in these instances, determine the downwind distance of Zone I by reading line ZULU from the NBC 3 (Nuclear) report. Only three digits will appear on the line —the Zone I downwind distance in kilometers. A circle of this radius drawn around ground zero will define Zone I. A second circle of twice this radius will define Zone II. Time of arrival of fallout will have no meaning in this case and will not be represented on the prediction plot.

b. The NBC 3 (Nuclear) report is modified to transmit the data for the special case of very low winds. Line YANKEE is not included since fallout can go in any direction around ground zero. Line ZULU will contain only three digits—the Zone I downwind distance in kilometers. For example:

	NBC 3 (Nuclear)
ALFA	24
DELTA	221000Z
FOXTROT	MN123456 (actual)
ZULU	015

To construct a prediction in this case, use the three digits in line ZULU as the radius of the Zone I circle. Double this distance, and draw the Zone II circle. This completes the prediction. No time-of-arrival arcs will be indicated.

Section V. EXAMPLE PROBLEMS

22. Example Problem 1. Preparation of a Detailed Fallout Prediction From the NBC 3 (Nuclear) Report

a. Situation. Assume that the S3, 3d Bn, 63d Inf, has received the following NBC 3 (Nuclear) report over one of the division's communications nets.

	NBC 3 (Nuclear)
ALFA	24
DELTA	240700Z
FOXTROT	MN340670 (actual)
YANKEE	02520292 (degrees)
ZULU	01903005

b. Action. Prepare the detailed fallout prediction. The first line, ALFA, is the strike serial number assigned by the CBRE at the operations center responsible for the area in which the strike occurs. The second line, DELTA, gives the date and time (GMT) of the burst. The third line, FOXTROT, gives the coordinates of ground zero, MN340670. The fourth line, YANKEE, gives the azimuths of the left and right radial lines of the predicted area. The first four digits, 0252, indicate that the left radial line is 252 degrees from grid north; the second four digits, 0292, indicate that the right radial line is 292 degrees from grid north. The fifth line, ZULU, has three sets of digits. The first three digits, 019, represent the effective wind speed in kilometers per hour. The effective wind speed multiplied by the time of interest in hours after the burst gives the estimated distance downwind at which fallout will arrive for the hour of interest. The second three digits, 030, represent the predicted downwind distance, in kilometers, of the Zone of Immediate Operational Concern (Zone I). The extent of the Zone of Secondary Hazard (Zone II) is twice the downwind distance of Zone I, or 60 kilometers. The last two digits, 05, give the cloud radius as 5 kilometers. The fallout prediction is shown in figure 7, with arrows indicating the use of the prediction dimensions derived from the report and used to construct the prediction.

23. Example Problem 2. Preparation of Wind Vector Plot (Field Artillery Wind Reporting System; not using plotting scale).

a. Situation. Assume that the following field

NBC 3 (NUCLEAR)

ALFA 24

DELTA 240700Z

FOXTROT MN340670 (actual)

YANKEE 0252 0292 (degrees)

ZULU 019 030 05

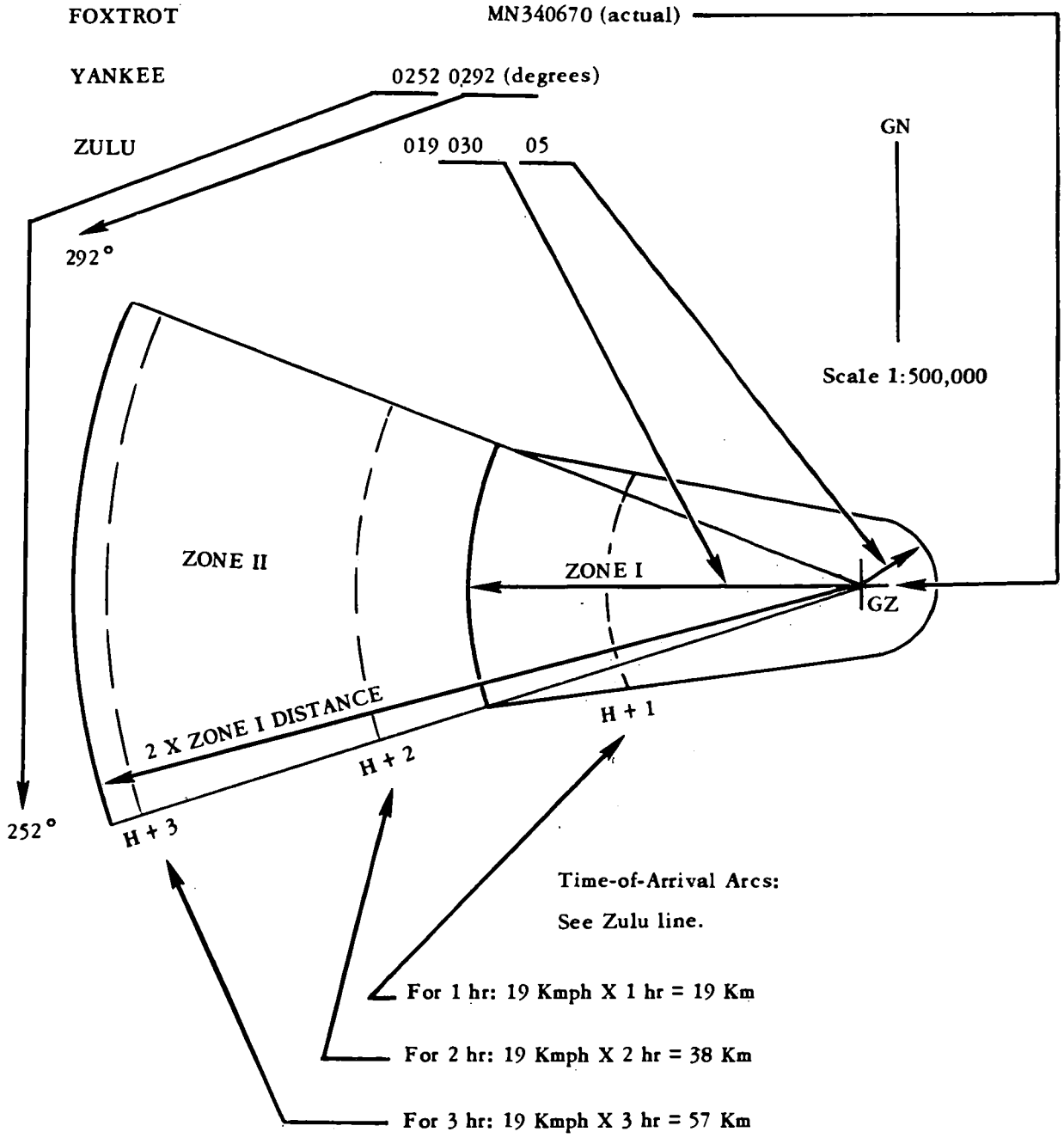


Figure 7. Example problem 1—Preparation of a detailed fallout prediction from the NBC 3 (Nuclear) report.

artillery upper air wind data have been received by the CBRE:

Wind layer (10^3 *meters*)	*Wind direction* (*mils*)	*Wind speed* (*knots*)
0–2	1240	9
2–4	1420	13
4–6	1600	18
6–8	1780	13
8–10	1960	9
10–12	2310	9
12–14	2850	13
14–16	3200	13
16–18	3560	18
18–20	3740	14
20–22	3820	18
22–24	3910	27
24–26	3910	26
26–28	3910	34

30 Balloon Burst

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.* Adjust wind data.

(*a*) The directions reported in upper air wind data are the directions *from* which the winds are blowing. Using the reported direction, obtain the direction toward which the fallout particles are being blown while falling through a wind layer by adding or subtracting 3,200 mils as applicable (add 3,200 mils if the reported direction is less than 3,200 mils and subtract if it is more than 3,200 mils).

(*b*) The horizontal distance in kilometers traveled by a nominal size particle (a spherical particle 143 microns in diameter) while falling through a wind layer is obtained by multiplying the reported wind speed in knots for the layer by the appropriate weighting factor from table 3 (chap 6). A worksheet showing step 1 is given below:

Wind layer (10^3 *meters*)	*Wind direction* (*mils*) *From*	*To*	*Wind speed* (*knots*) ×	*Weighting factor* (*from table 3*) =	*Vector length* (*km*)*
0–2	1240	4440	9	1.26	11.3
2–4	1420	4620	13	1.09	14.2
4–6	1600	4800	18	.96	17.3
6–8	1780	4980	13	.93	12.1
8–10	1960	5160	9	.89	8.0
10–12	2310	5510	9	.83	7.5
12–14	2850	6050	13	.78	10.1
14–16	3200	6400	13	.74	9.6
16–18	3560	360	18	.72	13.0
18–20	3740	540	14	.70	9.8
20–22	3820	620	18	.69	12.4
22–24	3910	710	27	.67	18.1
24–26	3910	710	26	.67	17.4
26–28	3910	710	34	.65	22.1

30 Balloon Burst

* Round off to nearest tenth of a kilometer.

(2) *Step 2.* Attach overlay paper to a piece of graph paper, a map, a firing chart, or any other paper with a set of parallel lines that can serve as north-south grid lines, select and mark a point which represents ground zero, and draw in and label a grid north line.

(3) *Step 3.* Select and record a map scale. (In this example, a map scale of 1 :500,000 will be used.)

(4) *Step 4.* Plot the wind direction and vector length for each wind layer, starting with the lowest layer.

(*a*) Plot the vector for the lowest (0- to 2,000-meter wind layer which represents a wind with a speed of 9 knots blowing from 1,240 mils. From GZ plot a line toward 4,440 mils 11.3 kilometers long. Mark the end of this vector with the number 2 to indicate 2,000-meter height (fig 8(1)).

(*b*) Starting at the point where the first vector ended, plot the second vector for the 2,000- to 4,000-meter layer which represents a wind with a speed of 13 knots blowing from 1,420 mils. This vector is plotted 14.2 kilometers long toward 4,620 mils. Mark the end of this vector with the number 4 to indicate 4,000-meter height (fig 8(2)).

(*c*) Starting at the point where the second vector ended, plot the third vector for the 4,000- to 6,000-meter layer which represents a wind with a speed of 18 knots blowing from 1,600 mils. This vector is plotted 17.3 kilometers long toward 4,800 mils. Mark the end of this vector with the number 6 to indicate 6,000-meter height (fig 8(3)).

(*d*) Plot the remaining vectors in the same manner, and label the end of each vector with the height it represents (fig 8(4)).

24. Example Problem 3. Prepration of Wind Vector Plot (Field Artillery Wind Reporting System; using plotting scale)

a. Situation. Assume that the following field artillery upper air wind data have been received by the CBRE:

Wind layer (10^3 *meters*)	*Wind direction* (*mils*)	*Wind speed* (*knots*)
0–2	1240	9
2–4	1420	13
4–6	1600	18
6–8	1780	13
8–10	1960	9
10–12	2310	9
12–14	2850	13
14–16	3200	13
16–18	3560	18
18–20	3740	14
20–22	3820	18
22–24	3910	27
24–26	3910	26
26–28	3910	34

30 Balloon Burst

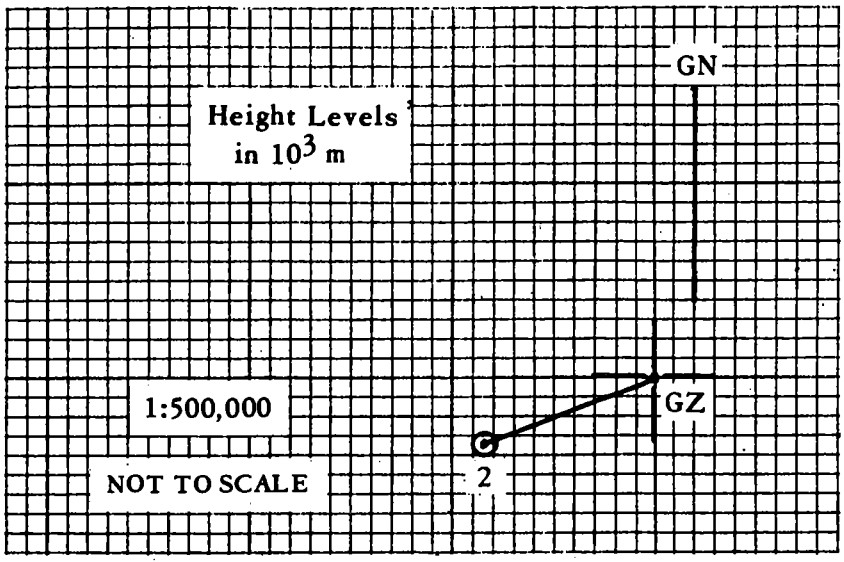


Figure 8 (1). Example problem 2—Preparation of wind vector plot from field artillery upper air wind data.

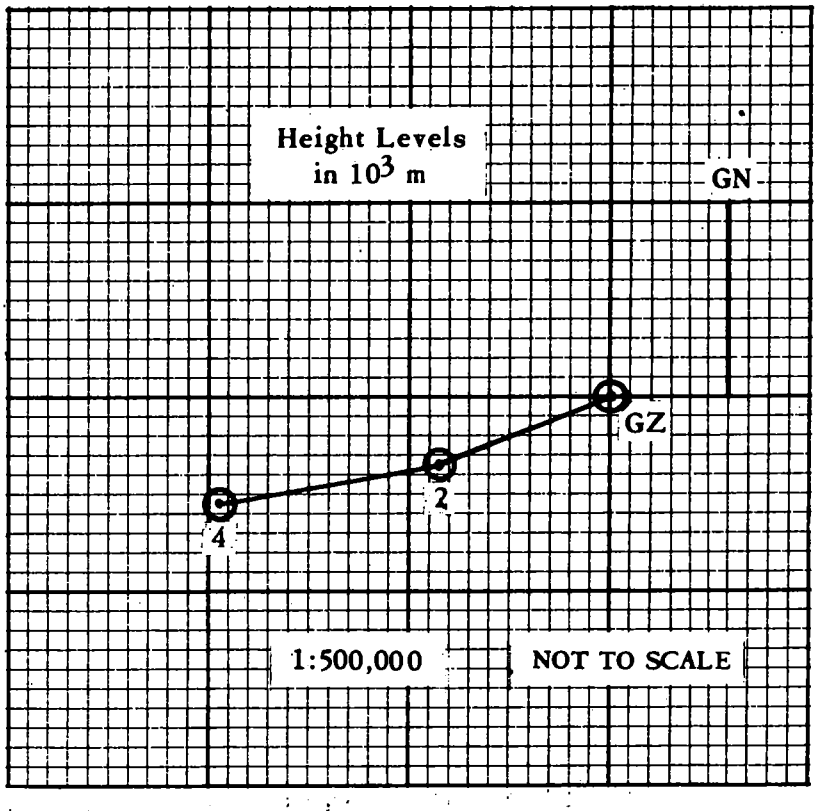


Figure 8 (2)—Continued.

b. Action. Using the fallout prediction plotting scale (fig 2), prepare the fallout wind vector plot as follows:

(1) *Step 1.* Attach overlay paper to a piece of graph paper, a map, a firing chart, or any other paper with parallel lines that can serve as north-south grid lines. Mark GZ, scale, height dimensions, and grid north on the overlay paper. Place the pinhole at the end of slot 1 (marked "0–2") over the point marked GZ; stick a pin or sharp

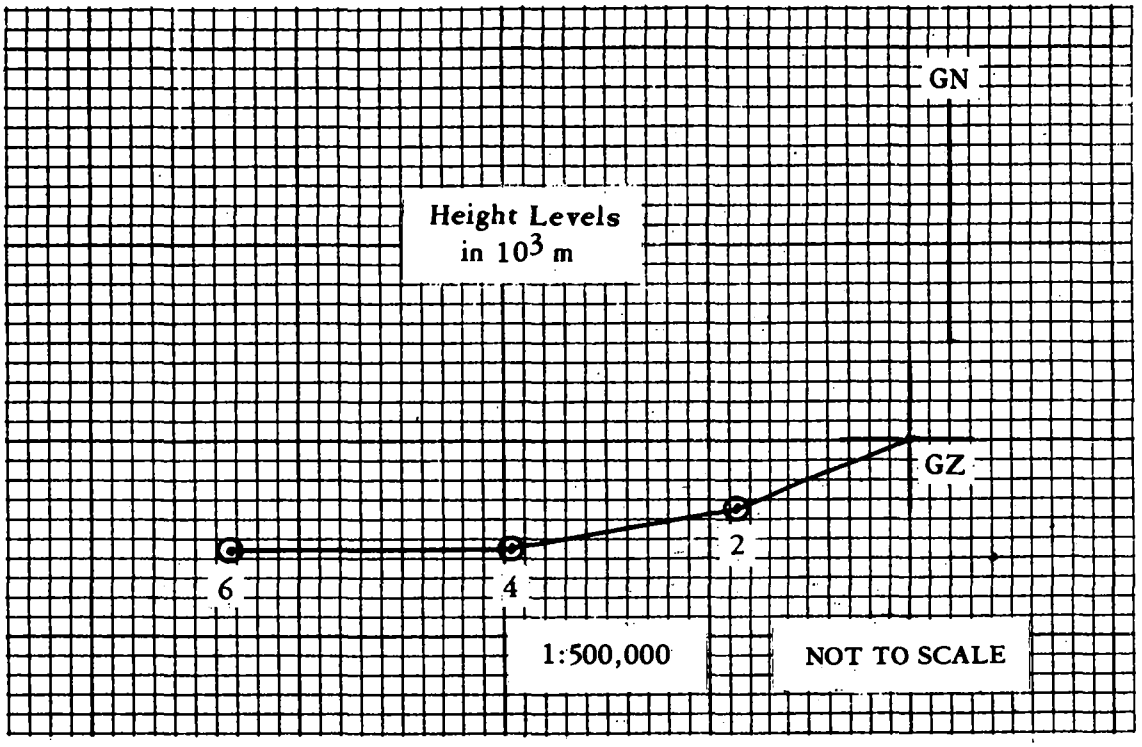


Figure 8 (3)—Continued.

pencil through the hole to hold that pinhole on GZ; rotate the plotting scale until the 1,240-mil line on the azimuth dial is parallel to any north-south line and directed toward grid north; draw a line in the 0–2 slot to 9 (9 knots) at the selected map scale. Mark the end of this vector with the number 2 to indicate 2,000-meter height.

(2) *Step 2.* Place the pinhole at the end of slot 2 (marked "2–4") at the end of the first vector; stick a pin or sharp pencil through the hole to hold the pinhole there; rotate the plotting scale until the 1,420-mil line on the azimuth dial is parallel to any north-south line and directed toward grid north; draw a line in the 2–4 slot to 13 (13 knots) at the selected map scale. Mark the end of this vector with the number 4 to indicate 4,000-meter height.

(3) *Step 3.* Place the pinhole at the end of slot 3 (marked "4–6") at the end of the second vector; stick a pin or sharp pencil through the hole to hold the pinhole there; rotate the plotting scale until the 1,600-mil line on the azimuth dial is parallel to any north-south grid line and directed toward grid north; draw a line in the 4–6 slot to 18 (18 knots) at the selected map scale. Mark the end of this vector with the number 6 to indicate 6,000-meter height.

(4) *Step 4.* Plot the remaining vectors in the same manner and label the end of each vector with the height it represents.

25. Example Problem 4. Preparation of Wind Vector Plot (Air Weather Service (AWS) Reporting System; using plotting scale)

a. Situation. Assume that the following upper air wind data have been received by the CBRE from the AWS detachment:

1 *Altitude above mean sea level of reported wind (10^3 feet)**	2 *Representing layer over local mean datum plane (10^3 feet)*	3 *Wind direction (degrees)*	4 *Wind speed (knots)*
5	0–5	180	9
10	5–10	190	9
15	10–15	210	13
20	15–20	210	17
25	20–25	230	17
30	25–30	250	13
35	30–35	260	26
40	35–40	310	20
45	40–45	310	17
50	45–50	320	18
55	50–55	320	18
60	55–60	320	10
65	60–65	320	10
70	65–70	320	18
75	70–75	340	18
80	75–80	320	24

*When local mean datum exceeds 5,000 feet above mean sea level, begin the plot with the 10,000-foot altitude of reported wind (column 1), and label vectors in 5,000-foot increments above the mean datum plane (subtract 5,000 feet from the figures listed in column 2 above).

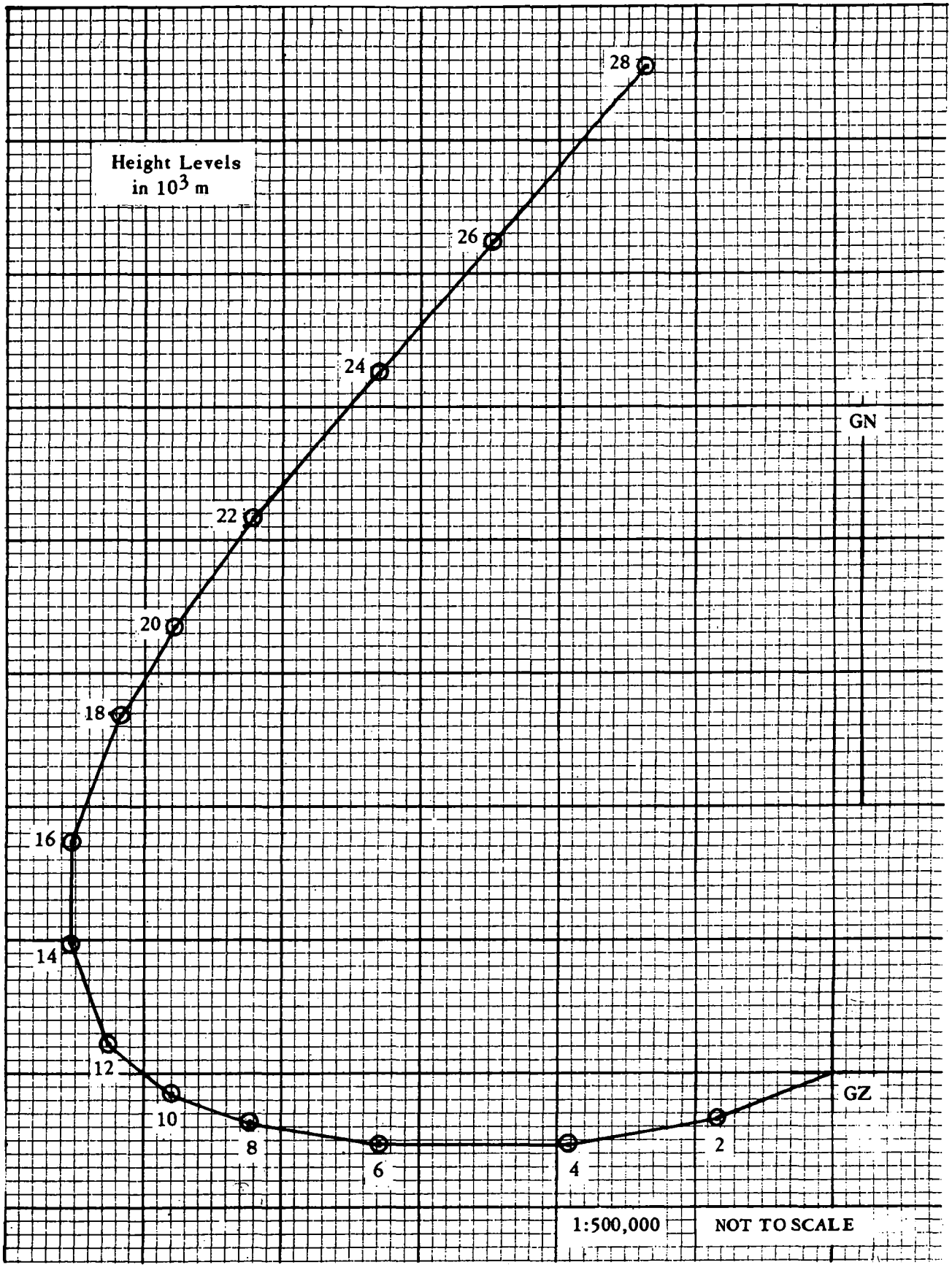


Figure 8(4)—Continued.

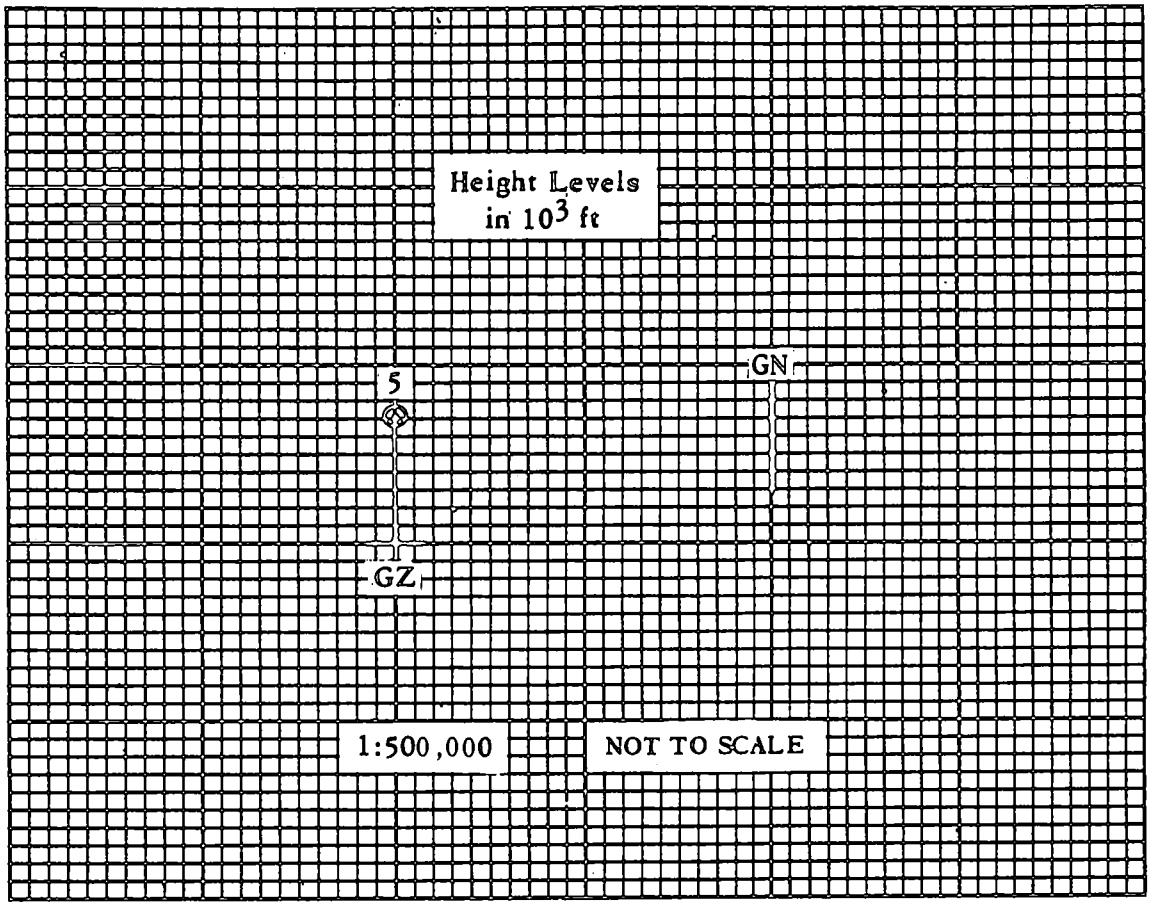


Figure 9(1). Example problem 4—Preparation of wind vector plot from AWS upper air wind data (using plotting scale).

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.* Attach overlay paper to a piece of graph paper, a map, a firing chart, or any other paper with a set of parallel lines that can serve as north-south grid lines, select and mark a point which represents ground zero and a grid north line.

(2) *Step 2.* Select and record a map scale. (In this example, a map scale of 1:500,000 will be used.

(3) *Step 3.* Using the plotting scale, plot the vector for each wind layer starting with the lowest layer. These vectors are plotted in the same manner as in example problem 3, *except that different slots are used for the various wind layers and one-half the reported wind speeds are used for wind layers above 45,000 feet.* Table 4 (chap 6) shows which plotting scale slot to use for the various wind layers.

(*a*) Plot the 0- to 5,000-foot wind layer vector by placing the pinhole of the 6–8 slot over the GZ point and rotating the plotting scale about the pinhole until the 180-degree line is parallel with grid north with the degree number up. Draw a line in the slot to the scaled value of 9 (9 knots). Mark the downwind end of this vector 5 to indicate the 5,000-foot height (fig 9(1)).

(*b*) Continue this procedure through the 40,000- to 45,000-foot layer, using the plotting scale slot for the various wind layers as indicated in table 4 (chap 6).

(*c*) Plot the 45,000- to 50,000-foot wind layer vector by placing the pinhole of the 2–4 slot over the end point of the 40,000- to 45,000-foot layer vector, and rotating the plotting scale about the pinhole until the 320-degree line is parallel with grid north with the degree number up. Draw a line in the slot to the scaled value of 9 (representing one-half of the 18-knot wind speed for the layer). Mark the downwind end of this vector 50 to indicate the 50,000-foot height. If the wind speed for any layer above the 40,000- to 45,000-foot level is an uneven number and a fractional figure is derived when dividing by one-half, round the scaled value up to the next higher number.

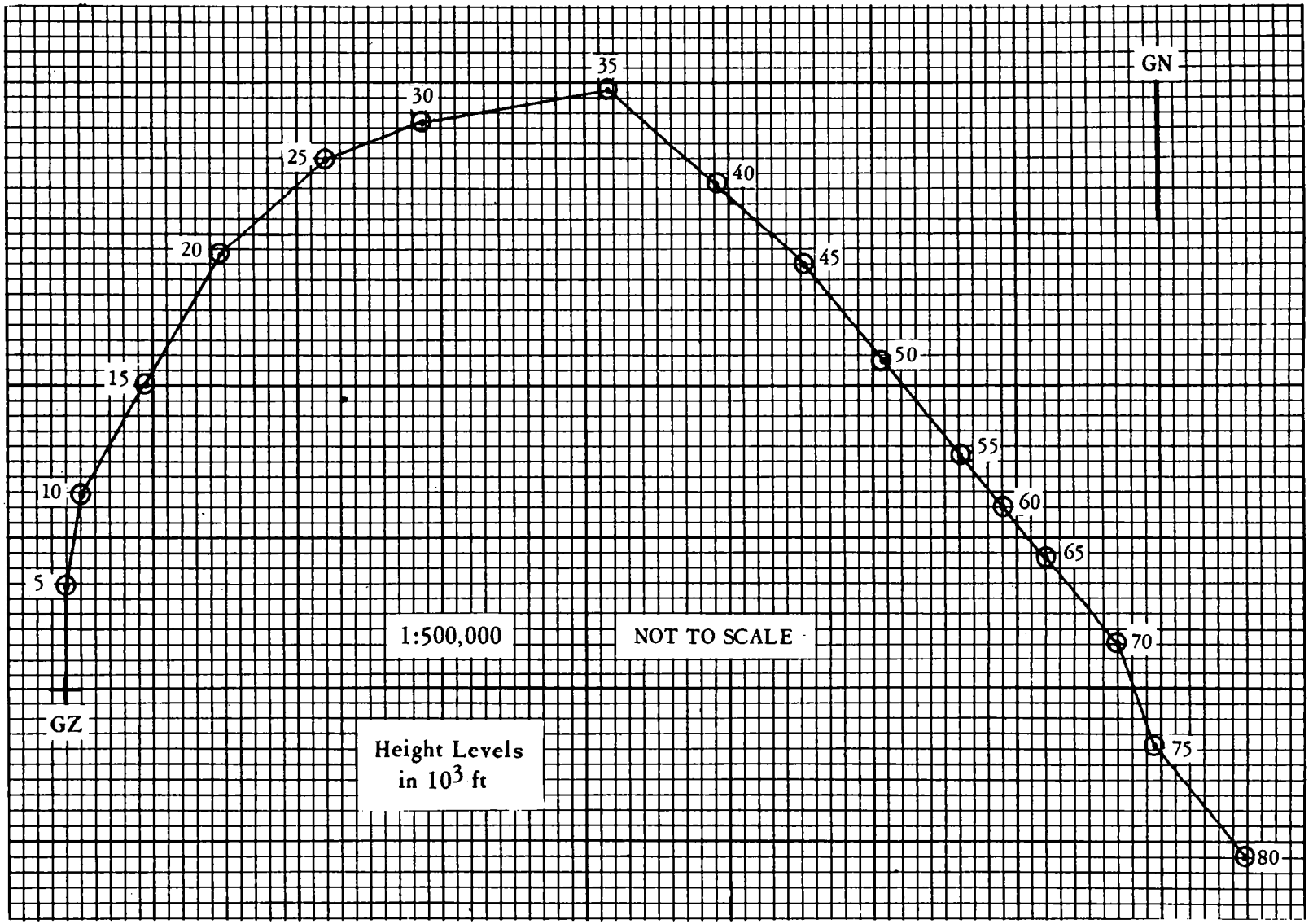


Figure 9(2)—Continued.

(*d*) Plot the remaining vectors of the wind vector plot in the same manner, using the slot designated for each wind layer indicated in table 4 (chap 6), and label the end of each vector by the height level it represents (fig 9(2)).

26. Example Problem 5. Preparation of Wind Vector Plot (AWS Constant Pressure Wind Reporting System; using plotting scale)

a. Situation. Assume that the following AWS meteorological data (constant pressure surfaces) have been received by the CBRE:

Constant pressure surface (millibars)	*Wind direction (degrees)*	*Wind speed (knots)*
850	140	20
700	100	16
600	90	18
500	80	21
400	80	22
300	80	25
200	70	20
150	60	18
100	60	16

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.*

(*a*) The plotting scale is used with constant pressure surface wind data in the same manner as in example problem 3, except that different slots are used for the different wind layers and the vector lengths are drawn to scaled values of each slot corresponding to adjusted wind speeds for each layer. The required slot designation and wind speed adjustment factor for each layer are found in table 5 (chap 6).

(*b*) A worksheet showing step 1 is given below:

Constant pressure surface (millibars)	*Represents wind layer (10^3 feet)*	*Wind direction (degrees)*	*Reported wind speed (knots)* × *Adjustment factor (from table 5)* = *Adjusted wind speed (knots)*	*Plotting scale slot to be used*
850	0–5	140	20 × 1 = 20	6–8
700	5–10	100	16 × 1 = 16	8–10
600	10–14	90	18 × 1 = 18	Above 26
500	14–18	80	21 × ½ = 11	2–4
400	18–24	80	22 × 1 = 22	10–12
300	24–30	80	25 × 1 = 25	10–12
200	30–39	70	20 × 1 = 20	2–4
150	39–45	60	18 × 1 = 18	14–16
100	45–53	60	16 × 1 = 16	6–8

(2) *Step 2.*

(*a*) Attach overlay paper to a piece of graph paper; mark GZ, scale, height dimensions, and grid north on the overlay paper. Place the pinhole of the *6–8 slot* of the plotting scale over the GZ point and rotate the plotting scale about the pinhole until the 140-degree line of the azimuth dial is parallel to grid north with the degree number up. Draw a line in the slot to the scaled number 20 (represents the adjusted wind speed for the 0- to 5,000-foot wind layer). Mark the downwind end of this vector 5 to indicate the 5,000-foot height.

(*b*) Place the pinhole of the *8–10 slot* over the end point of the first (0–5) vector, aline the plotting scale for a wind from 100 degrees and draw the second vector, using an adjusted wind speed of 16 knots. Label the end point of this second vector 10.

(*c*) Repeat this procedure for the other wind layers.

(*d*) Figure 10 shows the completed wind vector plot.

27. Example Problem 6. Preparation of Wind Vector Plot (For wind data from sources other than field artillery or AWS where weighting factor tables are not available and the plotting scale cannot be used)

a. Situation. Assume that the following upper air wind data have been received by the CBRE:

Wind layer (10^3 meters)	*Wind direction (mils)*	*Wind speed (meters/second)*
0–3	1200	5
3–6	1100	5
6–9	1000	7
9–12	800	8
12–15	600	10
15–20	500	10
20–25	500	12
25–30	400	8

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.* Correct upper air wind data to find the direction toward which the winds are blowing, and convert the wind speeds from meters per second (m/sec) to kilometers per hour. To convert the direction from which the winds are blowing to the direction toward which the winds are blowing, add or subtract 3,200 mils as applicable for each wind layer. To convert wind speeds from meters per second to kilometers per hour, multiply the wind speed in meters per second by the correction factor of 3.6.

$$\frac{1 \text{ meter}}{\text{sec}} \times \frac{1 \text{ km}}{10^3 \text{ meters}} \times \frac{3600 \text{ sec}}{1 \text{ hr}} = 3.6 \text{ kmph.}$$

Wind layer (10^3 m)	*Wind direction (mils)* From	To	*Reported wind speed (m/sec)* × *Correction factor (3.6)* = *Adjusted wind speed (kmph)**
0–3	1200	4400	5 × 3.6 = 18
3–6	1100	4300	5 × 3.6 = 18
6–9	1000	4200	7 × 3.6 = 25
9–12	800	4000	8 × 3.6 = 29
12–15	600	3800	10 × 3.6 = 36
15–20	500	3700	10 × 3.6 = 36
20–25	500	3700	12 × 3.6 = 43
25–30	400	3600	8 × 3.6 = 29

*Round off to nearest kilometer per hour.

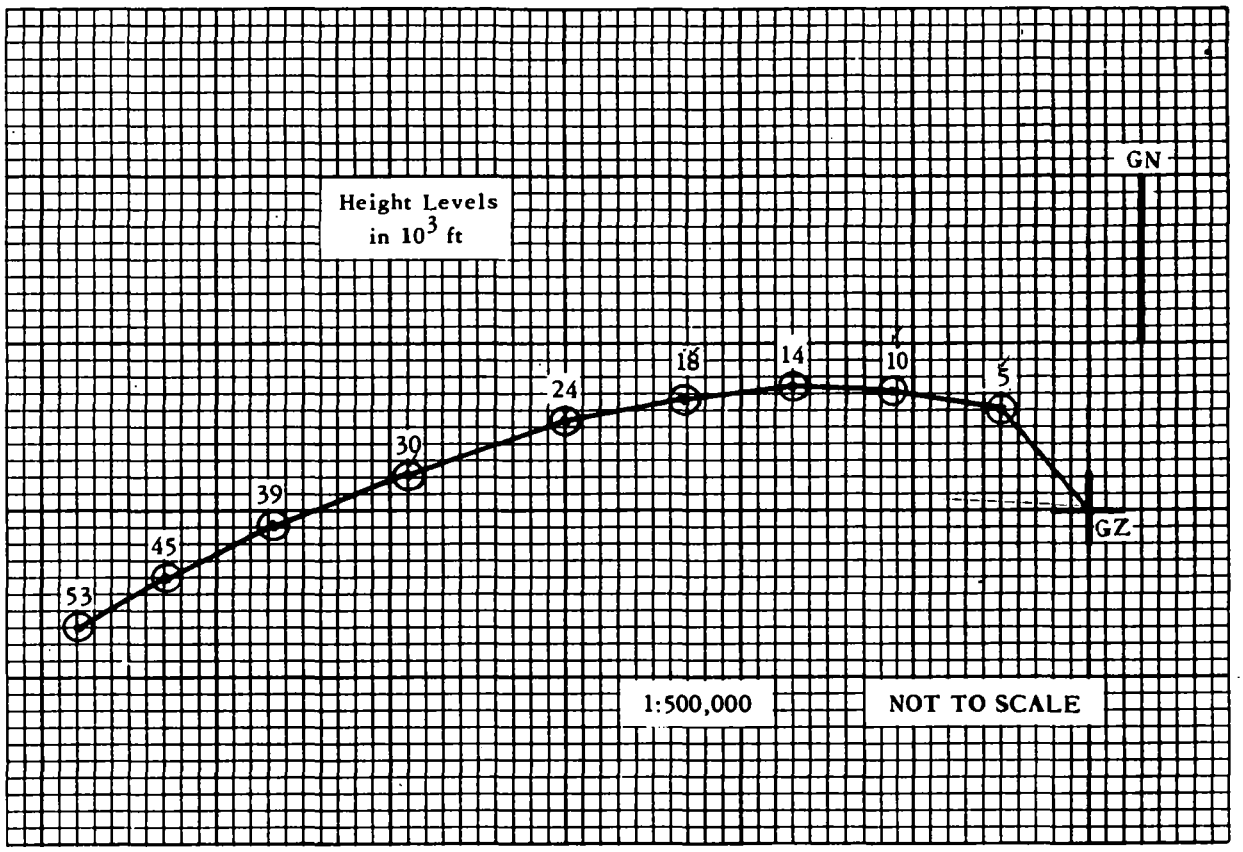


Figure 10. Example problem 5—Preparation of wind vector plot from AWS constant pressure surface data (using plotting scale).

(2) *Step 2.* Determine the time the nominal size particle will spend in each layer. The time in layer is determined first by finding the time for the particle to fall from each height level to the surface from figure 29 (chap 6). The time in layer (weighting factor) then is found by subtracting the time of fall to the ground from the bottom of the layer from the time of fall to the ground from the top of the layer. A worksheet showing step 2 is given below:

Height level (10^3 *m*)	*Time of fall to surface* (*hr*) (*fig. 29*)	*Wind layer* (10^3 *m*)	*Fall time from top* (*hr*)	= *Fall time from bottom* (*hr*)	= *Time in layer* (*hr*)
3	0.97	0–3	0.97	0	0.97
6	1.78	3–6	1.78	0.97	.81
9	2.53	6–9	2.53	1.78	.75
12	3.20	9–12	3.20	2.53	.67
15	3.83	12–15	3.83	3.20	.63
20	4.82	15–20	4.82	3.83	.99
25	5.72	20–25	5.72	4.82	.90
30	6.60	25–30	6.60	5.72	.88

(3) *Step 3.* Determine the vector length in kilometers for each wind layer. This is the distance in kilometers that the nominal size particle travels while falling through each layer. This distance is determined by multiplying the wind speed in kilometers per hour from step 1 by the time in layer in hours from step 2. A worksheet showing step 3 is given below:

Wind layer (10^3 *m*)	*Wind speed* (*kmph*) (*step 1*)	× *Time in layer* (*hr*) (*step 2*)	= *Vector length* (*km*)*	*Wind direction to* (*mils*)
0–3	18	0.97	17	4400
3–6	18	.81	15	4300
6–9	25	.75	19	4200
9–12	29	.67	19	4000
12–15	36	.63	23	3800
15–20	36	.99	36	3700
20–25	43	.90	39	3700
25–30	29	.88	26	3600

*Round off distances to the nearest kilometer.

(4) *Step 4.* Prepare the wind vector plot. The procedure in this case will be exactly parallel to the procedure of example problem 2, steps 2 through 4, since all terms are in the same dimensions.

28. Example Problem 7. Preparation of the Detailed Fallout Prediction

a. Situation. Assume that the wind vector plot

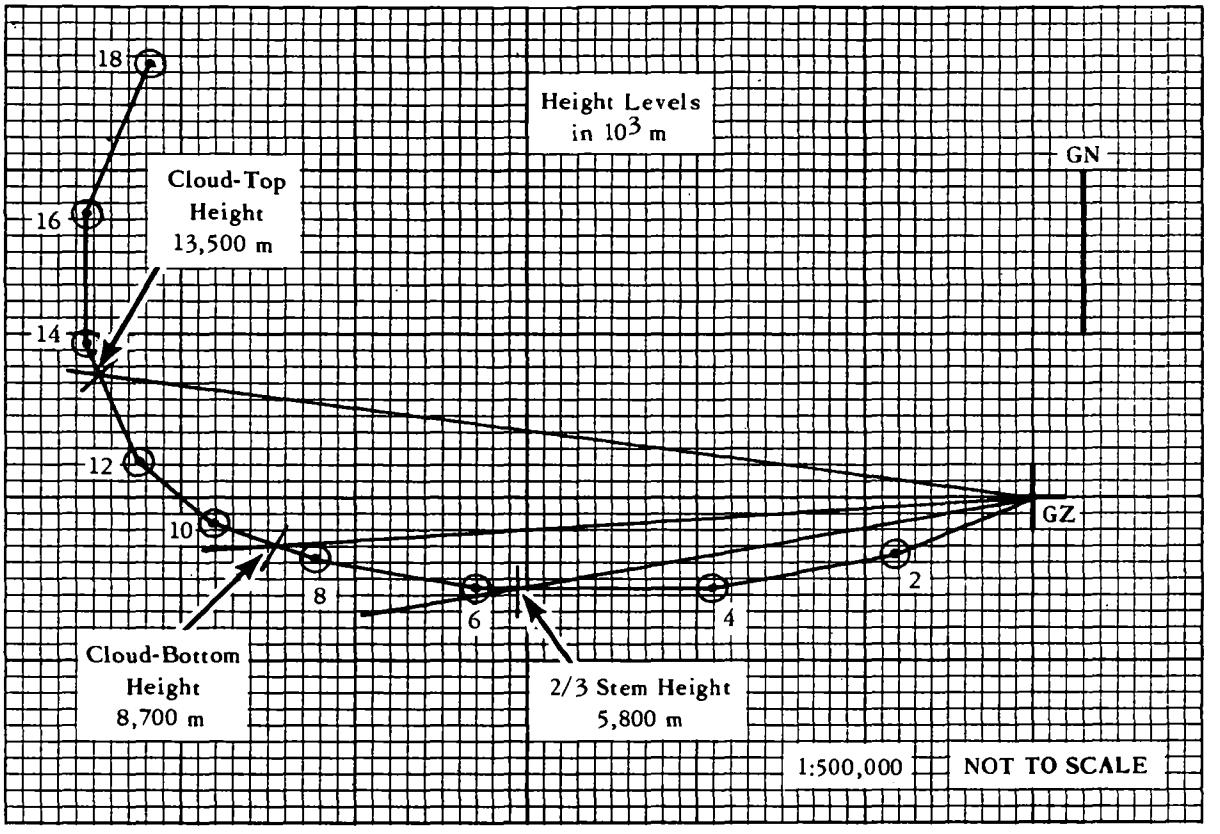


Figure 11(1). Example problem 7—Preparation of the detailed fallout prediction.

of example problem 2 is available as of 070030Z. Before the next upper air wind data are received, a series of NBC 1 (Nuclear) reports arrive at the CBRE. These reports indicate that a surface (fallout-producing) burst has occurred.

b. Action. Prepare a detailed fallout prediction, following the steps outlined in paragraph 19. The fallout wind vector plot has already been prepared to a map scale of 1:500,000 (fig 8(4), example problem 2). Complete the detailed fallout prediction worksheet (fig 12), using nuclear burst information provided and the values determined from the following steps:

(1) *Step 1.* Prepare the fallout wind vector plot. (Use the wind vector plot from example problem 2.)

(2) *Step 2.* Process the NBC 1 (Nuclear) reports, establishing the evaluated data contained in an NBC 2 (Nuclear) report as shown below. Record on lines a through e of the worksheet (fig 12).

(*a*) Yield is estimated as 70 KT.

(*b*) The burst occurred on 070100Z at MN345148 (actual).

(*c*) The burst was a surface burst.

(3) *Step 3.* Determine cloud parameters from figure 30. Place a straightedge horizontally across the figure so that the values of the yield on the left yield index scale and right yield index scale are the same (70 KT). Read the cloud-top height (13,500 meters), cloud-bottom height (8,700 meters), two-thirds stem height (5,800 meters), cloud radius (5.85 kilometers), and time of fall from cloud bottom (2.46 hours). Record on lines f through j of the worksheet (fig 12).

(4) *Step 4.* Cover the wind vector plot with a sheet of overlay paper, and mark the points representing cloud-top height, cloud-bottom height, and two-thirds stem height. Draw radial lines from GZ through these height points. Disregard vectors above the cloud-top height and below the two-thirds stem height. Check to see if any of the vectors *between* the cloud-top height and two-thirds stem height are outside these two radial lines (fig 11(9)). Since no vectors fall outside the radial lines, expansion of the radial lines is not necessary. Step 4 is shown in figure 11(1).

(5) *Step 5.* Determine the effective wind speed. On the fallout wind vector plot, measure

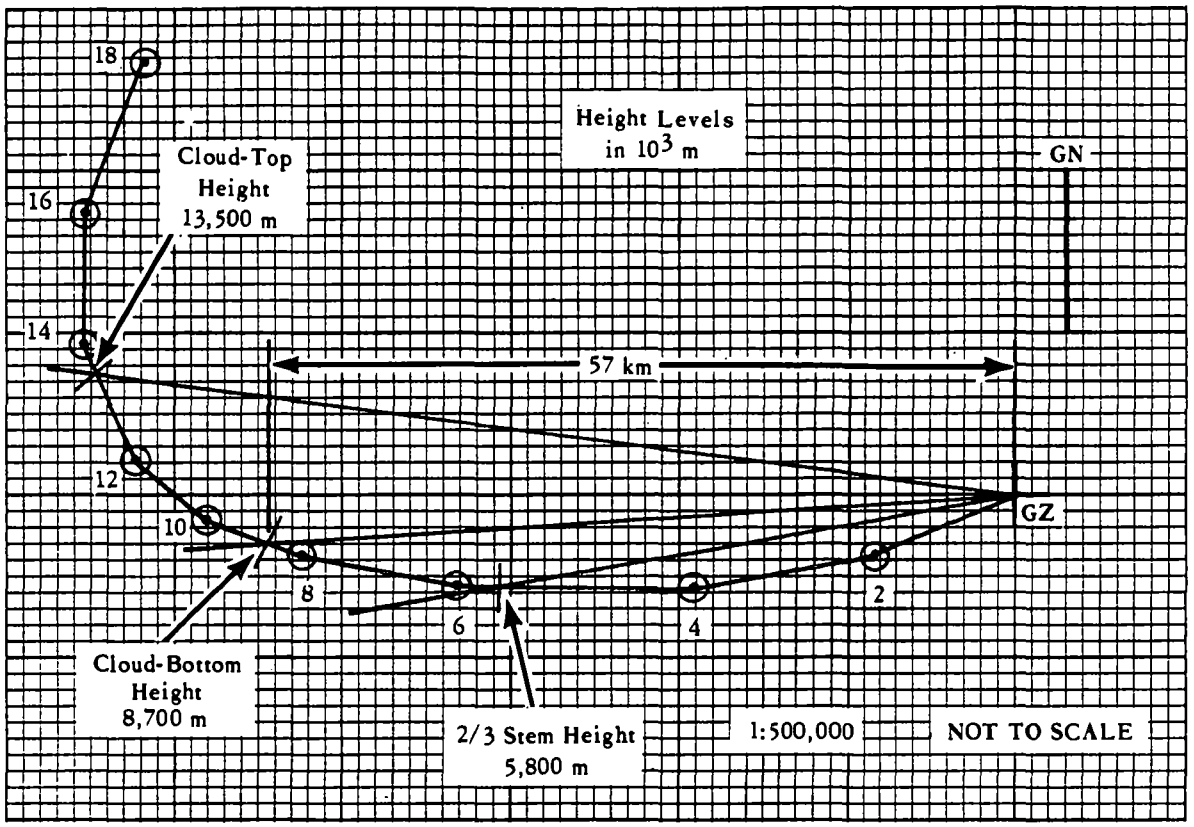


Figure 11(2)—Continued.

the length of the radial line from ground zero to cloud bottom height in kilometers (fig 11(2)). Record on line k of the worksheet (fig 12). Divide this distance by the time of fall from the cloud bottom, and record on line 1 of the worksheet (fig 12).

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

$$= \frac{57 \text{ km}}{2.46 \text{ hr}} = 23.2 \text{ kmph} = 23 \text{ kmph.}^*$$

* Round off to nearest kilometer per hour.

(6) *Step 6.* Determine the downwind distances of Zones I and II.

(*a*) Use figure 31. Lay a straightedge from the yield on the right-hand scale to the value of the effective wind speed on the left-hand scale; at the intersection of the straightedge with the center scale, read the downwind distance of the Zone of Immediate Operational Concern (Zone I). In this case read approximately 42 kilometers. Record on line m of the worksheet (fig 12). (Since this is a surface burst and the fission yield to total yield ratio is not known, adjustment is not necessary for the downwind distance; that is, HOB adjustment factor and FY/TY adjustment factor are both equal to 1.) Record the FY/TY adjustment factor of 1 and the HOB adjustment factor of 1 on line n of the worksheet. Record the downwind distance of Zone I on line o of the worksheet.

(*b*) Double this distance to determine the downwind distance of Zone II: $42 \times 2 = 84$ kilometers.

(7) *Step 7.* Construct the left and right radial lines.

(*a*) Measure the angle formed by the radial lines drawn from GZ through the cloud-top height point and two-thirds stem height point. In this case the angle is about 17 degrees. Since this angle is less than 40 degrees, bisect the angle and draw lines from GZ, 20 degrees to the left and 20 degrees to the right of the bisector (fig 11(3)).

(*b*) Measure the azimuths of the final left and right radial lines (248 degrees and 288 degrees), and record on lines p and q of the worksheet (fig 12).

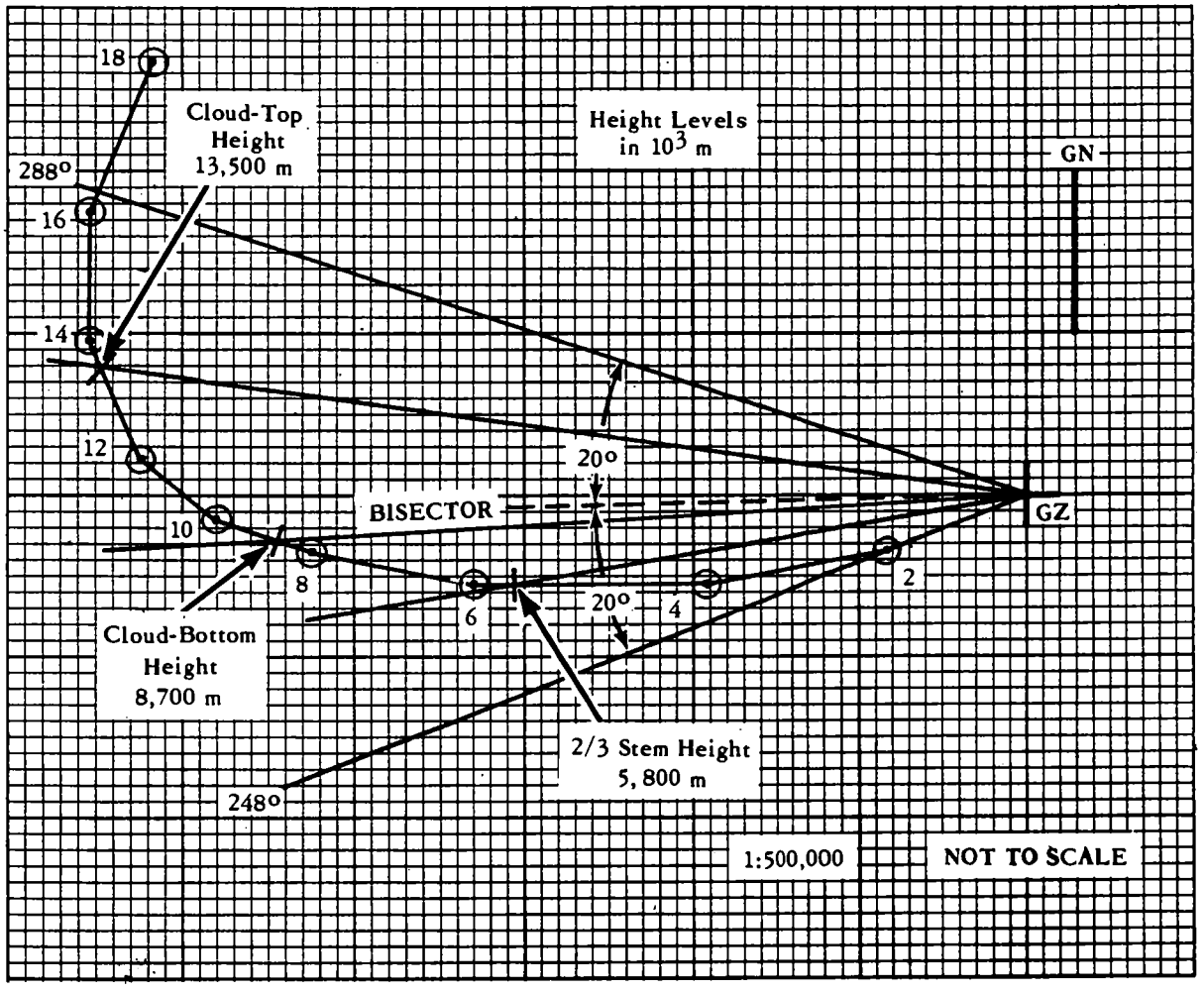


Figure 11(3)—Continued.

(8) *Step 8.* Complete the fallout prediction plot.

(*a*) On a sheet of overlay paper, mark ground zero, grid north, and the desired map scale. Trace the two radial lines (step 7) to any convenient distance.

(*b*) Between the extended radial lines drawn from GZ, and using GZ as center, draw two arcs at distances found in step 6 above (in this case 42 and 84 kilometers, respectively (fig 11(4)).

(*c*) Draw a circle around GZ with a radius equal to the rounded cloud radius (6.0 km) (fig 11(5)).

(*d*) Draw two tangents from the ground zero circle to the points of intersection of the two radial lines with the Zone I arc (fig 11(6)).

(*e*) Indicate estimated times of arrival of fallout by drawing dashed arcs at distances equal to the product of the effective wind speed and the hour of interest: 23 kilometers for 1-hour time of arrival, 46 kilometers for 2-hour time of arrival, and 69 kilometers for 3-hour time of arrival (fig 11(7)).

(*f*) To refine the prediction, place a clean sheet of overlay paper over the prediction, and draw in the outer boundary of the prediction; include the Zone I and Zone II arcs, estimated time-of-arrival arcs, and other essential data (fig 11(8)).

(9) *Step 9.* Prepare the NBC 3 (Nuclear) report. The report is completed by recording the strike serial number (para 16*b*(1)) and then by entering the data from lines a, b, p, q, l, o, and i (in that order) on line r of the worksheet (fig. 12). All figures entered in the ZULU line of the NBC 3 (Nuclear) report are rounded. Round off the effective wind speed to the nearest kilometer per hour; round off the downwind distance of Zone I to the nearest kilometer. Round up the cloud radius to the next kilometer if the value is not a whole number.

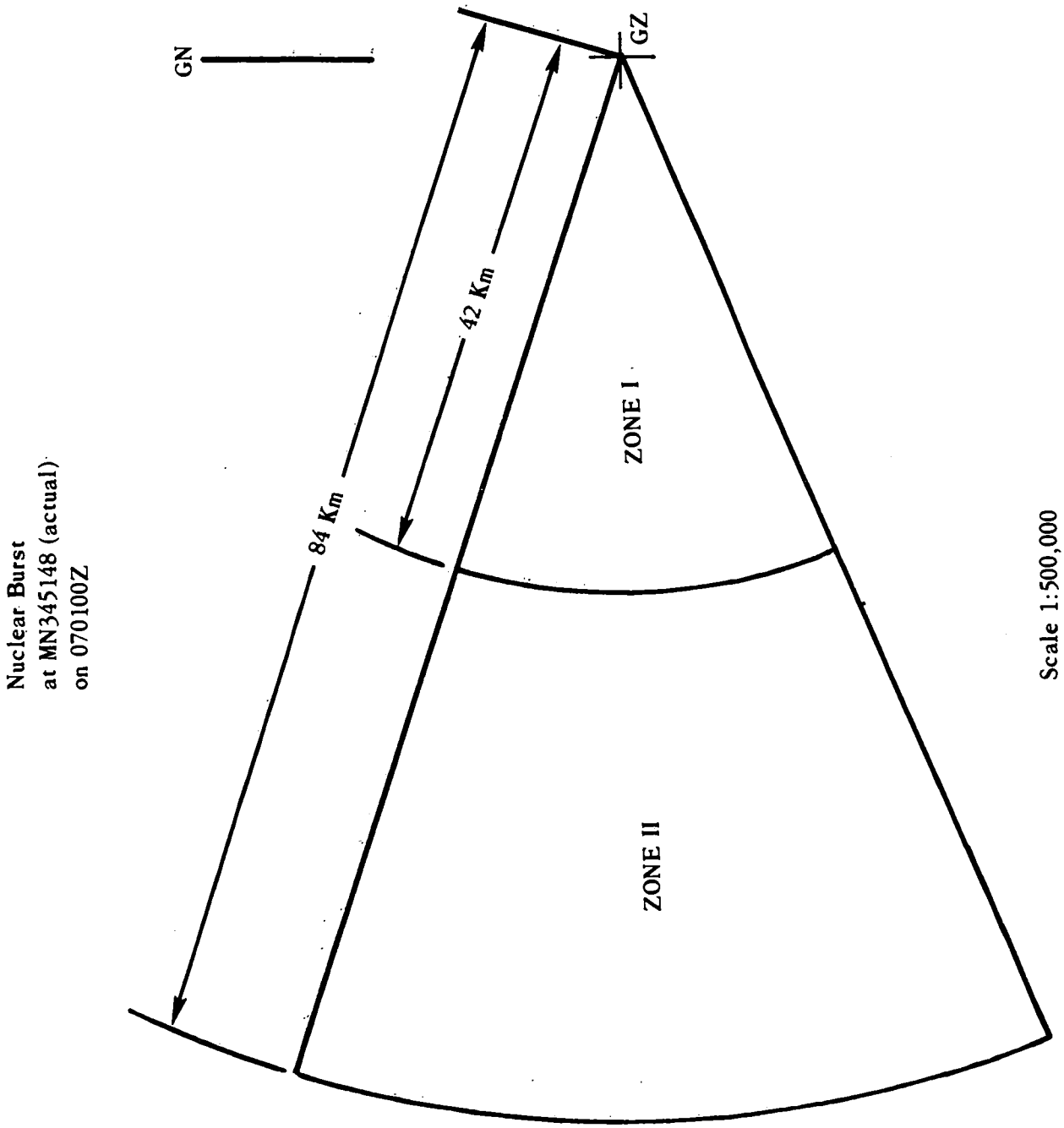


Figure 11 (4)—Continued.

	NBC 3 (Nuclear)
ALFA	24
DELTA	070100Z
FOXTROT	MN345148 (actual)
YANKEE	02480288 (degrees)
ZULU	02304206

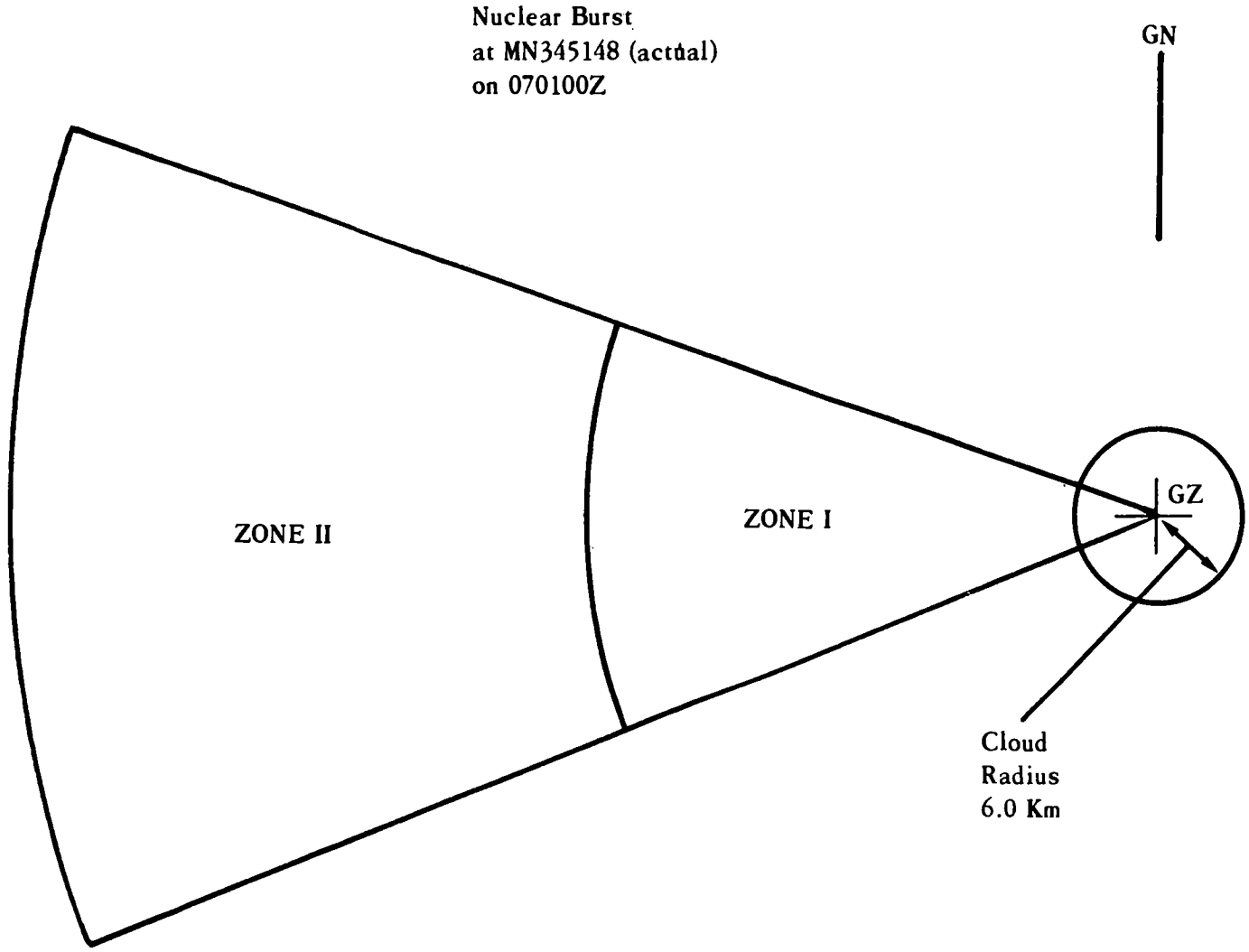
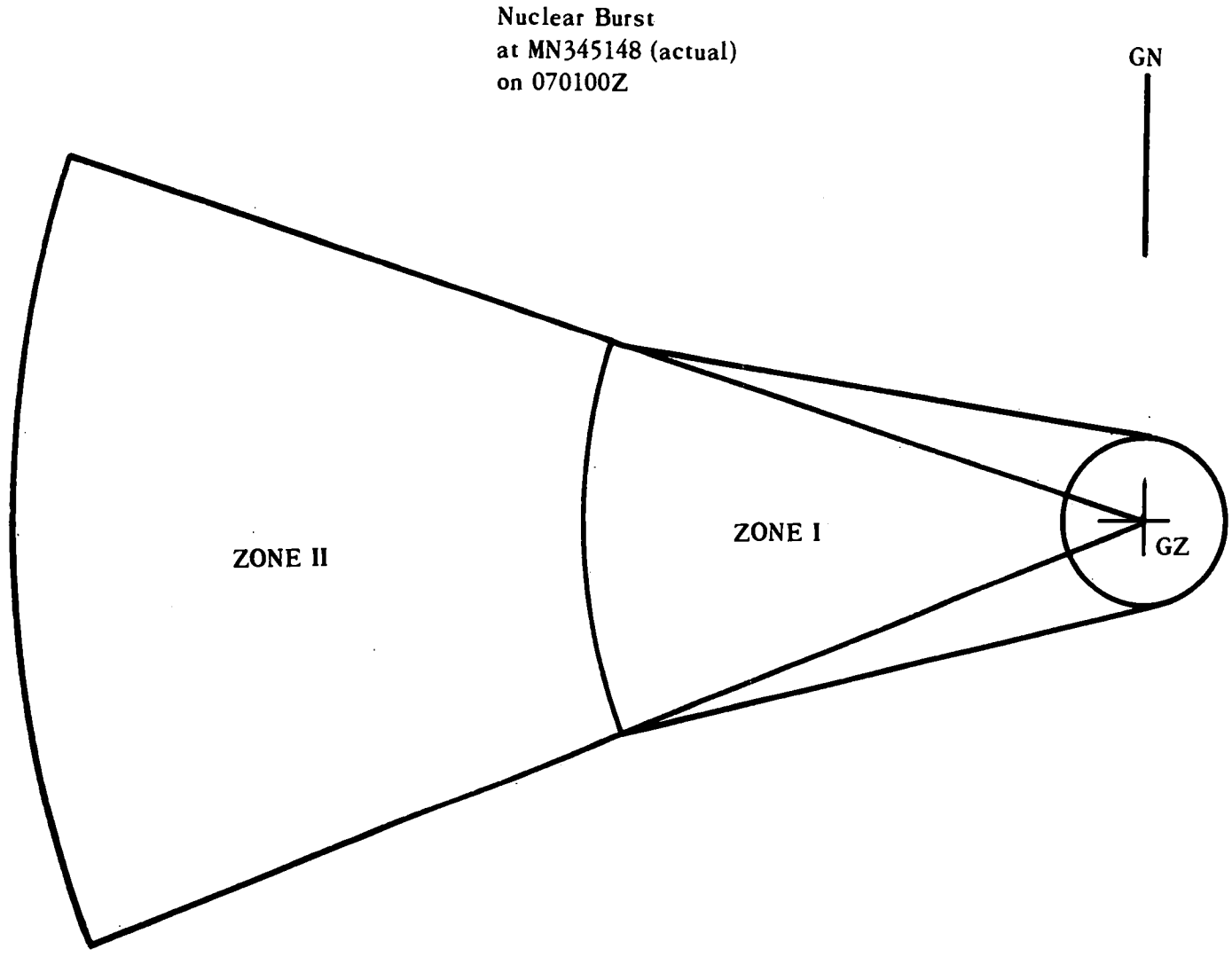


Figure 11 (5)—Continued.

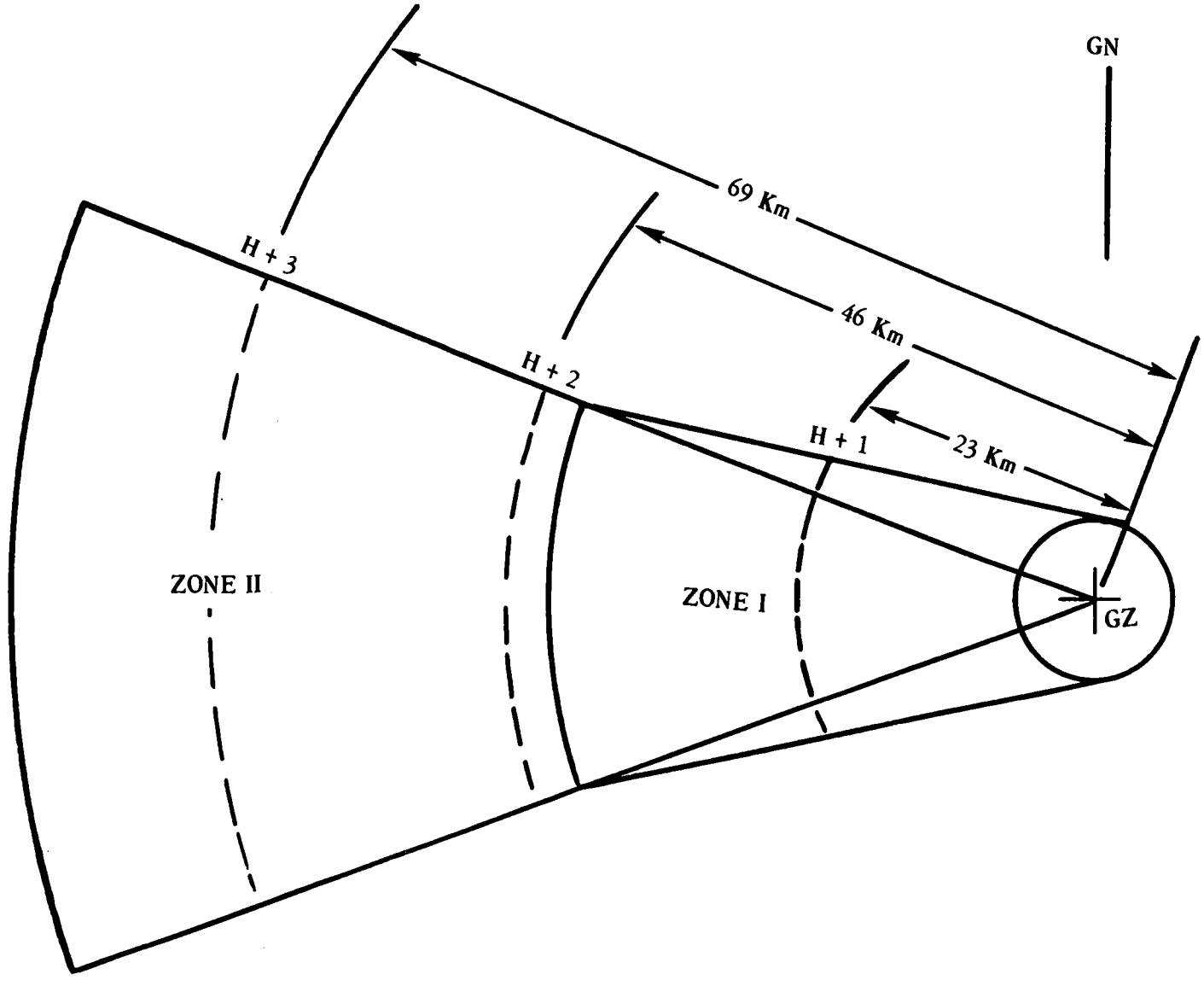
Scale 1:500,000



Scale 1:500,000

Figure 11(6)—Continued.

Nuclear Burst
at MN345148 (actual)
on 070100Z



Scale 1:500,000

Figure 11(7)—Continued.

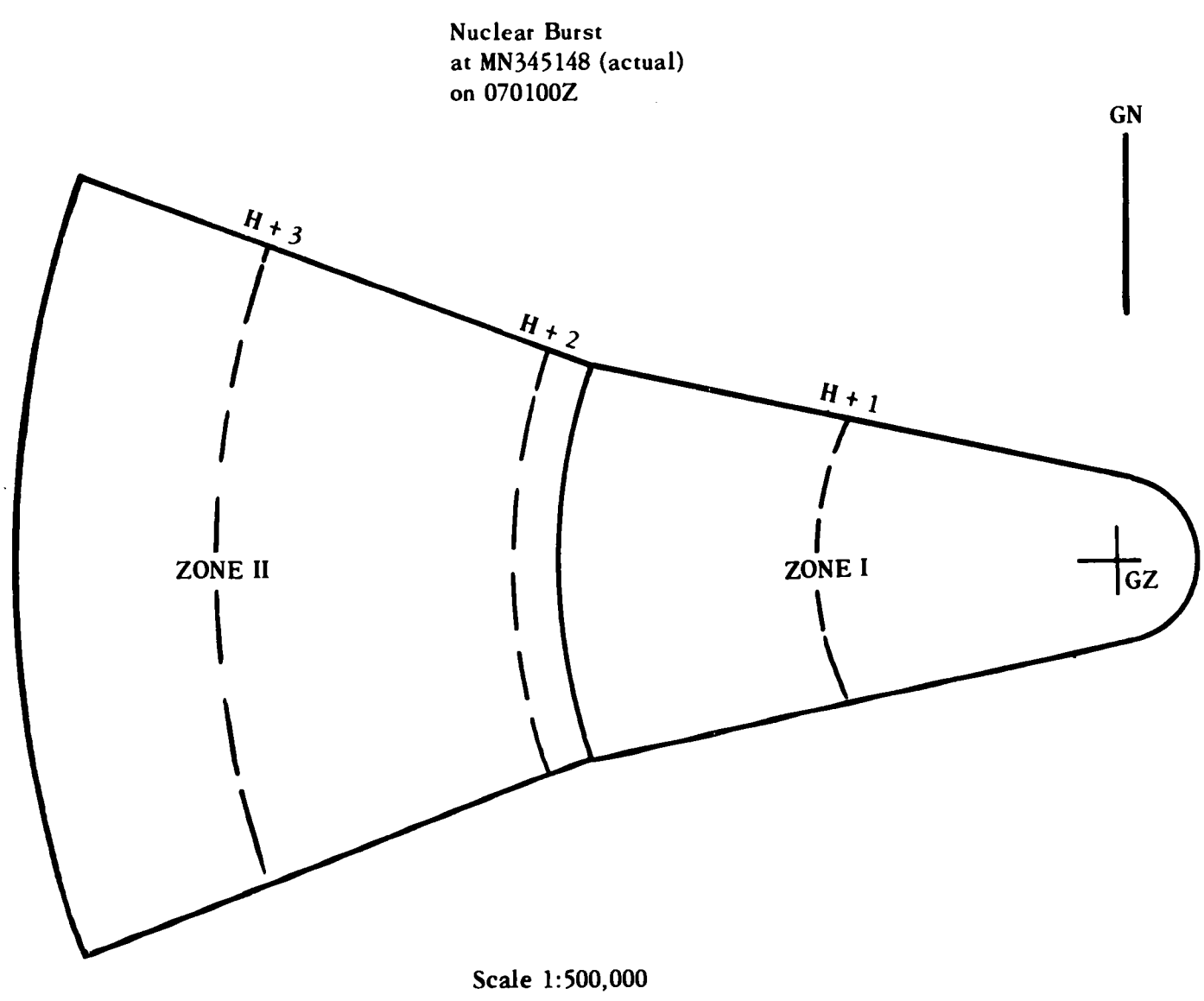


Figure 11(8)—Continued.

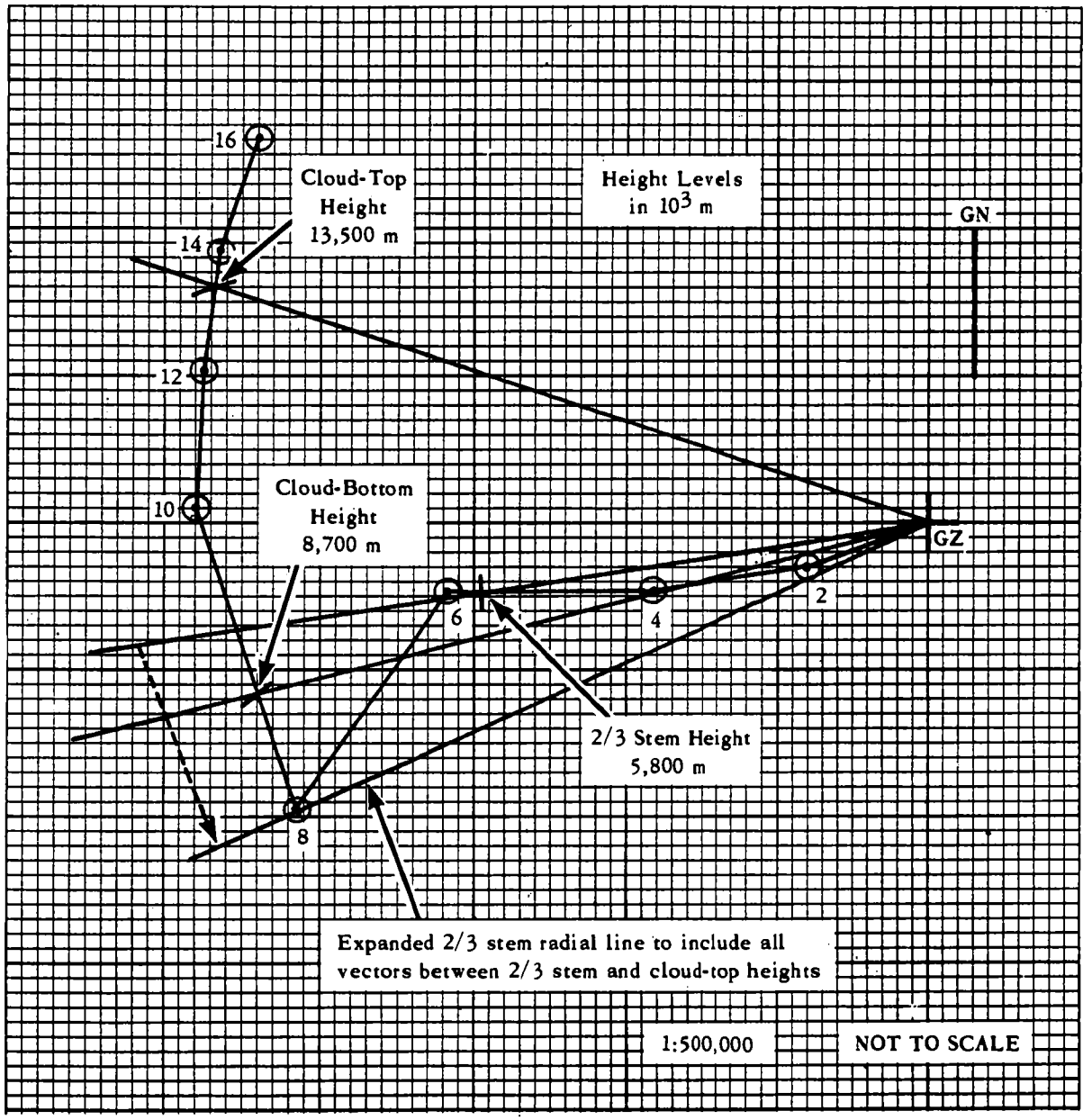


Figure 11(9). Expansion of radial line for a shear wind.

a. Time of Burst (date-time group) — 070100 — DELTA DDtttt (~~local or~~ ZULU)

b. GZ Coordinates — MN345148 — FOXTROT yyzzzzzz (actual ~~or estimated~~)

c. FY/TY Ratio (from target analyst for friendly weapons only) — 1

d. HOB (from target analyst for friendly weapons only) — 0 — meters

e. Yield — 70 — KT ~~or MT~~

f. Cloud-top Height (fig. 30) — 13.5 — 10^3 meters ~~or feet~~

g. Cloud-bottom Height (fig. 30) — 8.7 — 10^3 meters ~~or feet~~

h. 2/3 Stem Height (fig. 30) — 5.8 — 10^3 meters ~~or feet~~

i. Stabilized Cloud Radius (fig. 30) — 5.85 — ZULU rr (km)

j. Time of Fall from Cloud Bottom (fig. 30) — 2.46 — hours

Fallout Wind Vector Plot — (Enter f, g, and h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height.)

k. Radial Line Distance from GZ to Cloud-bottom Height — 57 — km

l. Effective Wind Speed = $\frac{\text{k (GZ-CB dist)}}{\text{j (Time of fall)}} = \frac{57}{2.46}\ \frac{\text{km}}{\text{hr}} =$ 23 ZULU sss (kmph)

m. Downwind Distance of Zone I (Enter fig. 31 with l and e.) — 42 — km

n. Adjustment = FY/TY Factor 1 (Enter fig. 34 with e and c or use one.) × HOB Factor 1 (Enter fig. 32 or 33 with d and e or use one.) = 1

o. Adjusted Downwind Distance of Zone I (m × n) — 42 — ZULU xxx (km)

Fallout Wind Vector Plot — (Check lateral limits for 40 degrees.)

p. Azimuth of Left Radial Line — 0248 — YANKEE dddd (~~mils or~~ degrees)

q. Azimuth of Right Radial Line — 0288 — YANKEE cccc (~~mils or~~ degrees)

r. NBC 3 (Nuclear)

ALFA	AAA	24	(strike serial number)
DELTA	DDtttt	070100	(~~local or~~ ZULU)
FOXTROT	yyzzzzzz	MN345148	(GZ coordinates—actual ~~or estimated~~)
YANKEE	ddddcccc	02480288	(azimuths of radial lines—~~mils or~~ degrees)
ZULU	sssxxxrr	023042 06	

(effective wind speed) (downwind distance) (cloud radius)

Figure 12. Examplee problem 7—Detailed fallout prediction worksheet (completed).

CHAPTER 3

SIMPLIFIED FALLOUT PREDICTION (STANAG 2103, ABCA QSTAG 123)

Section I. SIMPLIFIED FALLOUT PREDICTION TECHNIQUES

29. Description

a. The simplified fallout prediction method is provided to enable small unit commanders to make an *immediate* estimate of the location of the potential fallout hazard without waiting for a detailed fallout prediction message (NBC 3 (Nuclear) report).

b. The simplified prediction method requires nuclear burst information (para 6*b*), a current effective downwind message (para 30), and a simplified fallout predictor (para 31).

c. The lateral or angular limits of a simplified fallout predictor are fixed at 40 degrees; this is in contrast to the determination of lateral limits from current winds in the detailed method. These fixed angular limits are based upon climatological studies. In most cases these fixed angular limits are sufficient to encompass the fallout area of hazard. Cases where these limits are exceeded will be handled as explained in paragraph 32*j*(1).

30. Effective Downwind Message

a. Use of a simplified fallout predictor requires knowledge of the effective wind speed and downwind direction. This information is prepared by the CBRE as an effective downwind message and is transmitted to subordinate and adjacent units each time new upper air wind data are received. The latest effective downwind message should always be used. Effective downwind messages more than 12 hours old should not be used for fallout prediction.

b. The format for the effective downwind message will be a series of seven lines preceded by the phrase "Effective Downwind Message," as follows:

	Effective Downwind Message
ZULU	DDtttt (local or ZULU, state which)
ALFA	dddsss
BRAVO	dddsss
CHARLIE	dddsss
DELTA	dddsss
ECHO	dddsss
FOXTROT	dddsss

c. The significance of each letter item is indicated below:

(1) ZULU DDtttt—This line is the date-time at which the winds were measured, with DD the day and tttt the hour in local or ZULU time (GMT).

(2) The remaining lines provide data for the six preselected yield groups, where ddd is the effective downwind direction in degrees from grid north and sss is the effective wind speed to the nearest kilometer per hour.

(*a*) ALFA dddsss is the data line for the 2-kiloton (KT) or less yield group.

(*b*) BRAVO dddsss is the data line for the more than 2-KT through 5-KT yield group.

(*c*) CHARLIE dddsss is the data line for the more than 5-KT through 30-KT yield group.

(*d*) DELTA dddsss is the data line for the more than 30-KT through 100-KT yield group.

(*e*) ECHO dddsss is the data line for the more than 100-KT through 300-KT yield group.

(*f*) FOXTROT dddsss is the data line for the more than 300-KT through 1-megaton (MT) yield group.

(3) For example, if the DELTA line of an effective downwind message reads DELTA 090025, the person using this information would know that the DELTA line is used when the yield of the weapon is in the range from more than 30 KT through 100 KT. The contents of this DELTA line would indicate that the fallout prediction would be determined from an effective downwind direction of 90 degrees and an effective wind speed of 25 kilometers per hour.

(4) Any one or more of the data lines of the effective downwind message may contain only

three digits when the special case applies (para 32*j*(2)).

31. Area Predictor, Radiological Fallout, M5A2

The Area Predictor, Radiological Fallout, M5A2 (fig 13), is a transparent device used to outline the zones of hazard resulting from surface or near-surface bursts for preselected yield groups. The M5A2 fallout predictor is composed of two simplified predictors and a nomogram for determining the downwind distance of Zone I. One simplified predictor is drawn to a scale of 1 : 50,000, with five preselected yield groups (A, B, C, D, E) ; and one predictor is drawn to a scale of 1 : 250,000, with six preselected yield groups (A, B, C, D, E, F).

a. Each simplified predictor consists of three major parts:

(1) An azimuth dial for orientation.

(2) Semicircles depicting stabilized nuclear cloud radii drawn about ground zero and showing the area of contamination for each of the preselected yield groups.

(3) A map scale calibrated in kilometers along two radial lines extending out from the center of the azimuth dial.

b. The nomogram (fig 14), consisting of three scales, is positioned between the radial lines of the M5A2 fallout predictor and is used to determine the downwind distance of Zone I. The nomogram is not required for field constructed predictors (para 33).

(1) The left-hand scale is the effective wind speed in kilometers per hour.

(2) The center scale is the downwind distance of Zone I in kilometers.

(3) the right-hand scale is the yield in kilotons.

c. The Area Predictor, Radiological Fallout, M5A2, may be requisitioned through supply channels, using FSN 6665–106–9595.

32. Procedures for Use of Simplified Method

a. Information Required. Use of the M5A2 fallout predictor requires a current effective downwind message, an actual or estimated yield of the nuclear weapon detonated, and location of ground zero. Normally, the user of the M5A2 fallout predictor will have to obtain the yield and the location of ground zero from measured data or from the NBC 2 (Nuclear) report.

b. Identification of the Prediction. The prediction is identified by recording the location of ground zero and the date-time of burst on the predictor.

c. Effective Wind Speed and Downwind Direction. The effective wind speed and downwind direction for the burst are taken from the appropriate yield group data line of the effective downwind message (para 30).

d. Downwind Distances of the Zones. The downwind distance of the Zone of Immediate Operational Concern (Zone I) is determined from the nomogram (fig 14) on the M5A2 fallout predictor. This determination is made by connecting the value of the effective wind speed and the point on the yield scale representing the yield (using the actual or estimated yield, not the yield group) with a straightedge. The value of the downwind distance of Zone I, in kilometers, is read at the point of intersection of the straightedge and the Zone I downwind distance scale. The downwind distance of Zone II is twice that of Zone I. Arcs are drawn between the two radial lines, using GZ as center, with radii equal to the two downwind distances determined.

e. Tangents. Tangents are drawn from the cloud radius line for the yield group considered (*c* above) to the points of intersection of the radial lines of the predictor with the arc representing the downwind distance of Zone I (*d* above).

f. Perimeter. Zones I and II are labeled, and the remainder of the prediction perimeter is darkened with a grease pencil to emphasize the area of hazard.

g. Time-of-Arrival Arcs. Time-of-arrival arcs of interest are drawn in, using the effective wind speed and the procedure in paragraph 17*b*.

h. Orientation. Next, the fallout predictor ground zero point is placed over the actual or assumed GZ on the map, and the entire fallout predictor is rotated until the effective downwind direction in degrees on the azimuth dial is pointing toward grid north. The scale of the M5A2 fallout predictor and the map must be the same.

i. Evaluation. The simplified fallout prediction is now complete, and the operational aspects of the fallout hazard can be evaluated.

j. Special Cases.

(1) Infrequently, the fallout wind vector plot prepared by the CBRE may indicate a warning area angle greater than 40 degrees. In these in-

AREA PREDICTOR, RADIOLOGICAL FALLOUT, M5A2

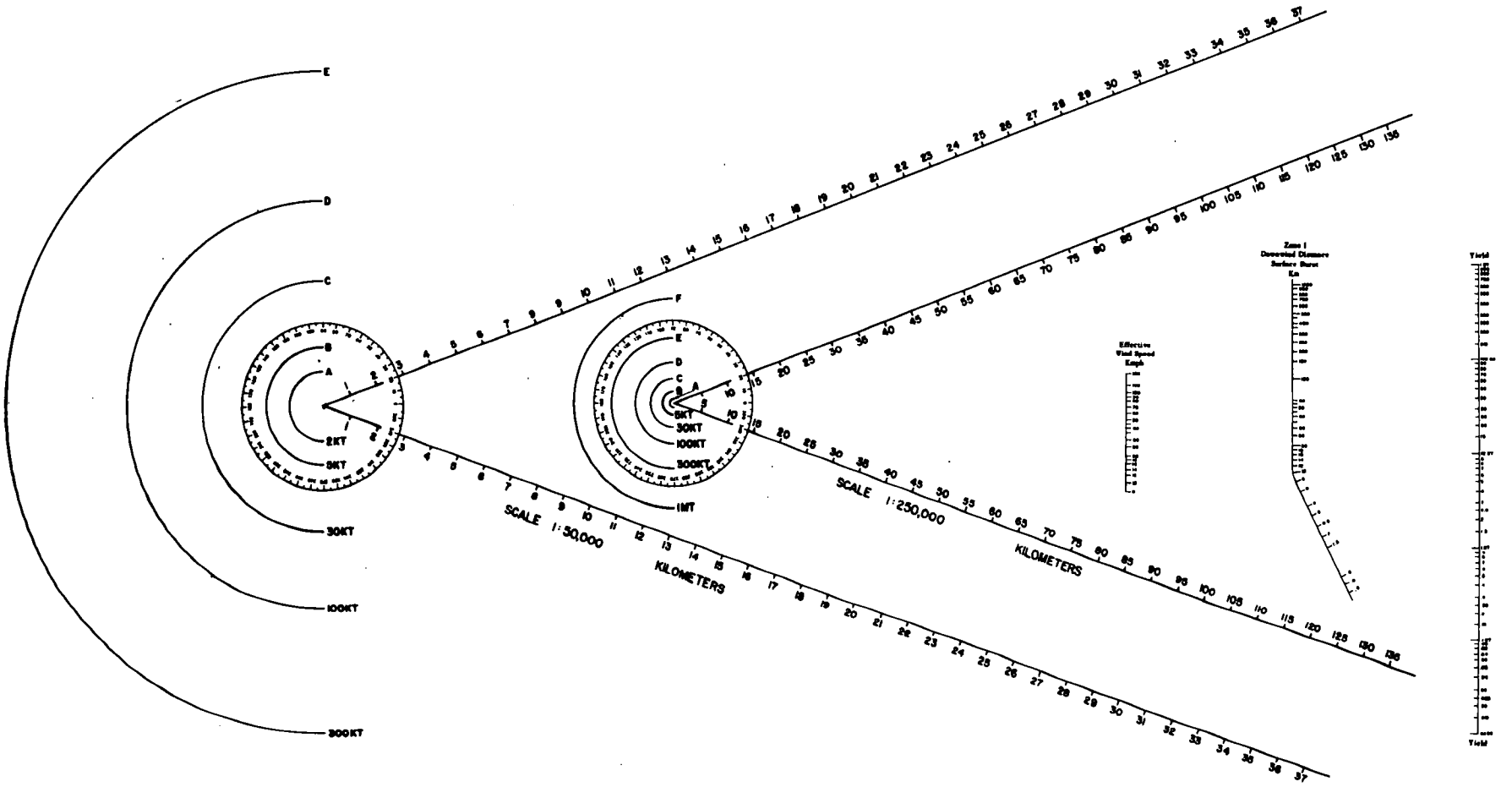


Figure 13. The M5A2 radiological fallout area predictor.

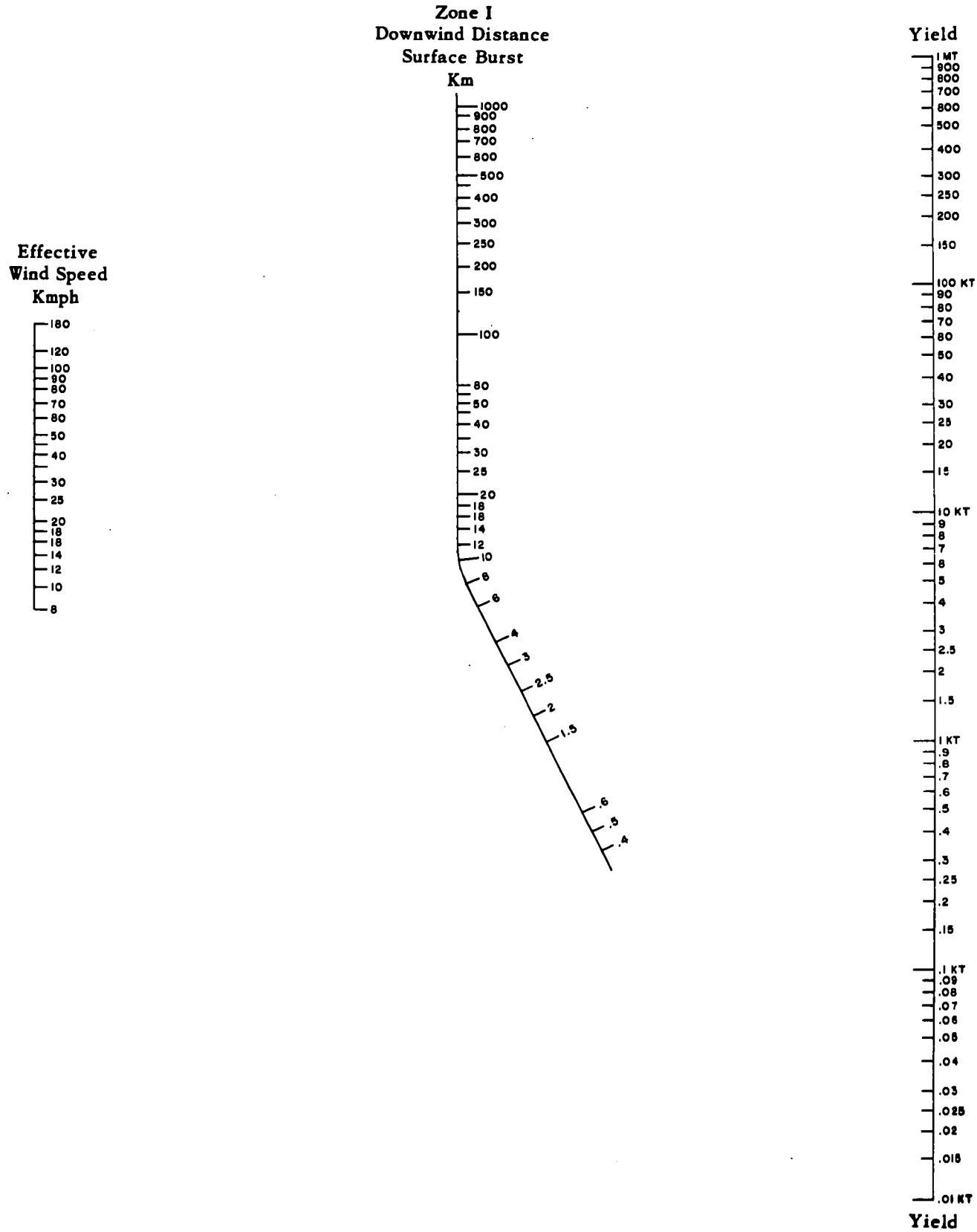


Figure 14. Zone I downwind distance nomogram on the M5A2 fallout predictor.

stances, the greater angle will be given beside the particular line of the effective downwind message for the yield group affected. Using units will expand the warning area beyond the fixed 40-degree angle of the simplified fallout predictor to correspond with the angle given at the side of the particular line of the effective downwind message (para 37*b*).

(2) A special case may arise when one or more of the data lines on the effective downwind message may contain only three digits. The three digits are the Zone I downwind distance for the highest yield in the yield group of interest and an effective wind speed of 8 kilometers per hour, as determined from the nomogram (fig 14). In this case, the fallout prediction will be prepared as described in paragraph 21.

k. Example. An example problem (para 34) illustrates the use of the M5A2 fallout predictor in the preparation of a simplified fallout prediction.

33. Field Construction of Simplified Fallout Predictor

a. If the fallout predictor shown in figure 13 is not available, a predictor can be constructed from any pliable, transparent material to any desired map scale by the following procedure:

(1) *Step 1.* Select an appropriate map scale. On a piece of pliable, transparent material or overlay paper, draw a thin dotted line (reference line) to a scaled length of 50 kilometers from a point selected to represent ground zero (fig 15(1)).

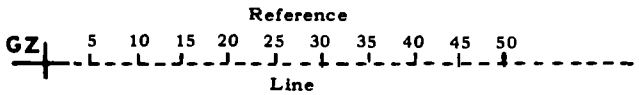


Figure 15(1). Construction of simplified fallout predictor.

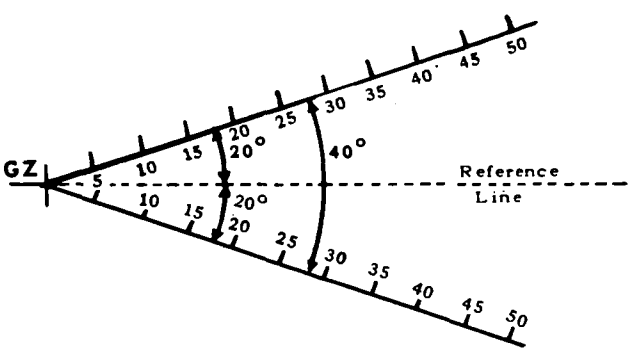


Figure 15(2)—Continued.

(2) *Step 2.* Draw and graduate in kilometers two radial lines from ground zero at angles of 20 degrees to the left and to the right of the dotted reference line (fig 15(2)).

(3) *Step 3.* On the side of ground zero opposite the reference line, draw a series of concentric semicircles (using the selected map scale) having radii of 1.2 kilometers, 1.9 kilometers, 4.2 kilometers, 6.8 kilometers, 11.2 kilometers, and 18.0 kilometers, which correspond to stabilized cloud radii from nuclear bursts with yields of 2 KT, 5 KT, 30 KT, 100 KT, 300 KT, and 1 MT (1,000 KT) respectively (fig 15(3)).

(4) *Step 4.* Label the semicircles constructed in step 3. Starting with the semicircle closest to GZ and moving up from GZ, label the semicircles A, B, C, D, E, and F; moving down from GZ, label the semicircles 2 KT, 5 KT, 30 KT, 100 KT, 300 KT, and 1 MT (1,000 KT) (fig 15(3)).

b. To use the field-constructed fallout predictor, determine the downwind distance of the Zone of Immediate Operational Concern from figure 31 and complete the simplified fallout prediction, using the procedures established in paragraph 32. The resulting prediction is then oriented by placing a protractor over an actual or assumed GZ on the map and drawing a line to represent the effective downwind direction for the yield group of interest. Place ground zero of the predictor over ground zero on the map, and rotate the predictor until its reference line coincides with the effective downwind direction.

34. Example Problem. Use of the M5A2 Fallout Predictor

a. Situation. Assume that the S3, 2d Bn, 62d Inf, has the following effective downwind message available:

Effective Downwind Message	
ZULU	240600Z
ALFA	080015
BRAVO	085015
CHARLIE	090016
DELTA	100010
ECHO	110025
FOXTROT	120020

At about 240730Z a nuclear burst occurred at a point estimated to be MN553298. A measurement of the flash-to-bang time and nuclear burst cloud width indicates an estimated yield of 16 KT.

b. Action. Use the M5A2 fallout predictor to make a fallout prediction. The estimated yield (16 KT) lies within the yield group CHARLIE

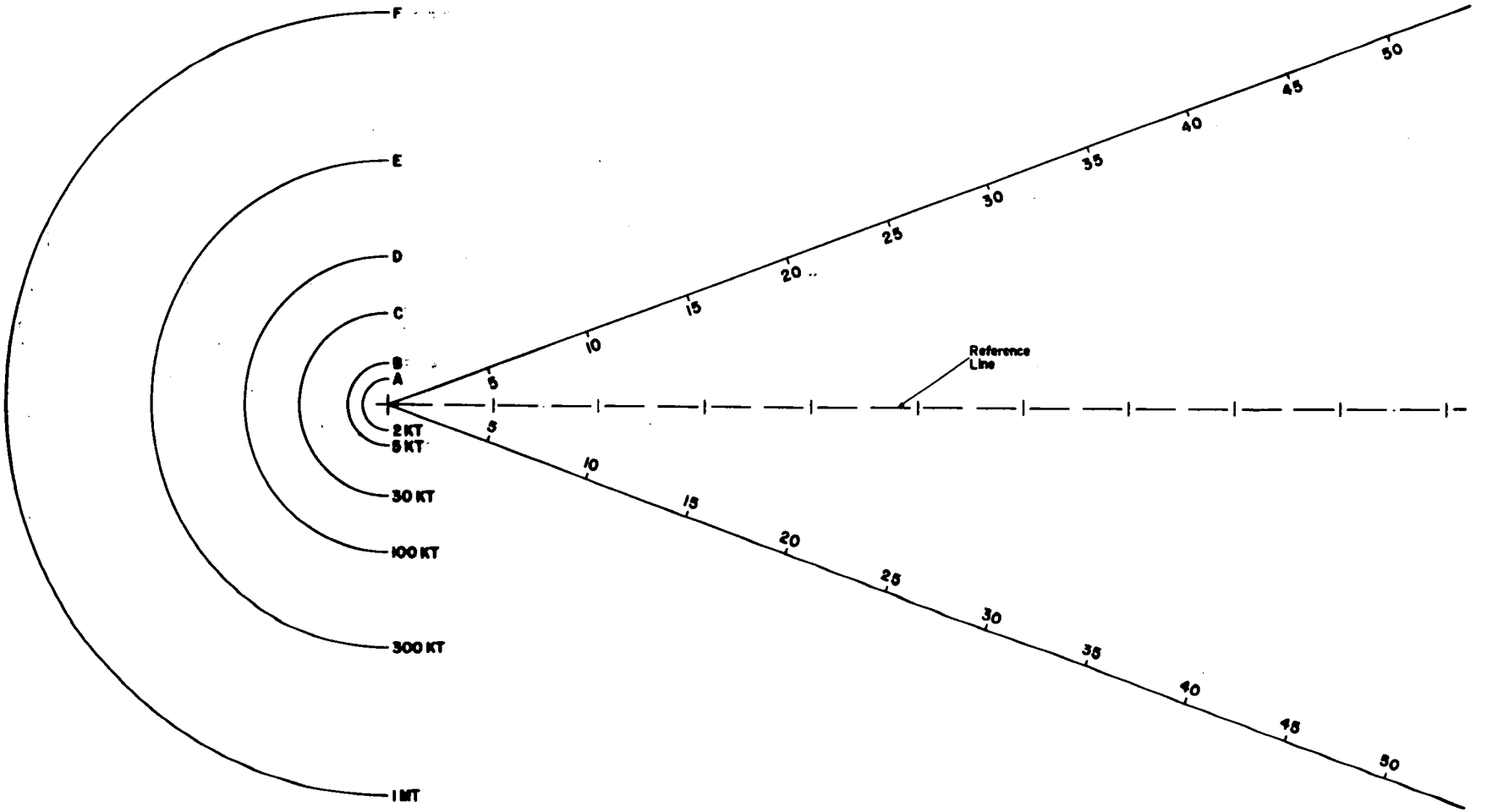


Figure 15 (3)—Continued.

(5+ to 30 KT). Therefore, use the effective downwind direction and effective wind speed from line CHARLIE of the effective downwind message, and use the "C" semicircle on the fallout predictor. From the nomogram on the predictor, using a yield of 16 KT and an effective wind speed of 16 kilometers per hour, read the downwind distance of the Zone of Immediate Operational Concern (Zone I) to be 18 kilometers. Draw an arc between the radial lines of the predictor at a distance of 18 kilometers downwind from ground zero (fig 16). Double this distance, and draw a second arc between the radial lines of the predictor at a distance of 36 kilometers downwind from ground zero. Draw straight lines tangent to the 30-KT cloud radius semicircle and extending to the intersection points of the Zone I arc with the radial lines. The area enclosed by the two lines, the 30-KT semicircle and the 18-kilometer arc, is the predicted Zone of Immediate Operational Concern (Zone I). The area enclosed by the 18-kilometer and 36-kilometer arcs and the radial lines is the predicted Zone of Secondary Hazard (Zone II). Draw a series of dashed arcs at distances equal to the product of the effective wind speed (16 kilometers per hour) and the hours of interest after the burst to represent the estimated times of arrival of fallout (16 kilometers at H+ 1 and 32 kilometers at H + 2) (fig 16). Arcs that fall outside Zone II need not be drawn. Draw a straight line from the center of the azimuth dial through the effective downwind direction (90 degrees) on the azimuth dial, and label the line grid north (GN). Place the center of the azimuth dial on the predictor over the estimated GZ (MN553298) on the map (the scales of the map and predictor must correspond), and rotate the predictor around the ground zero point until the GN line is pointing toward grid north. The predictor is now oriented so that fallout is going toward 90 degrees. The area covered by fallout can now be evaluated. As an example, at figure 1 can be seen a schematic depicting unit boundaries with coordinating points at the forward edge of the battle area (FEBA).

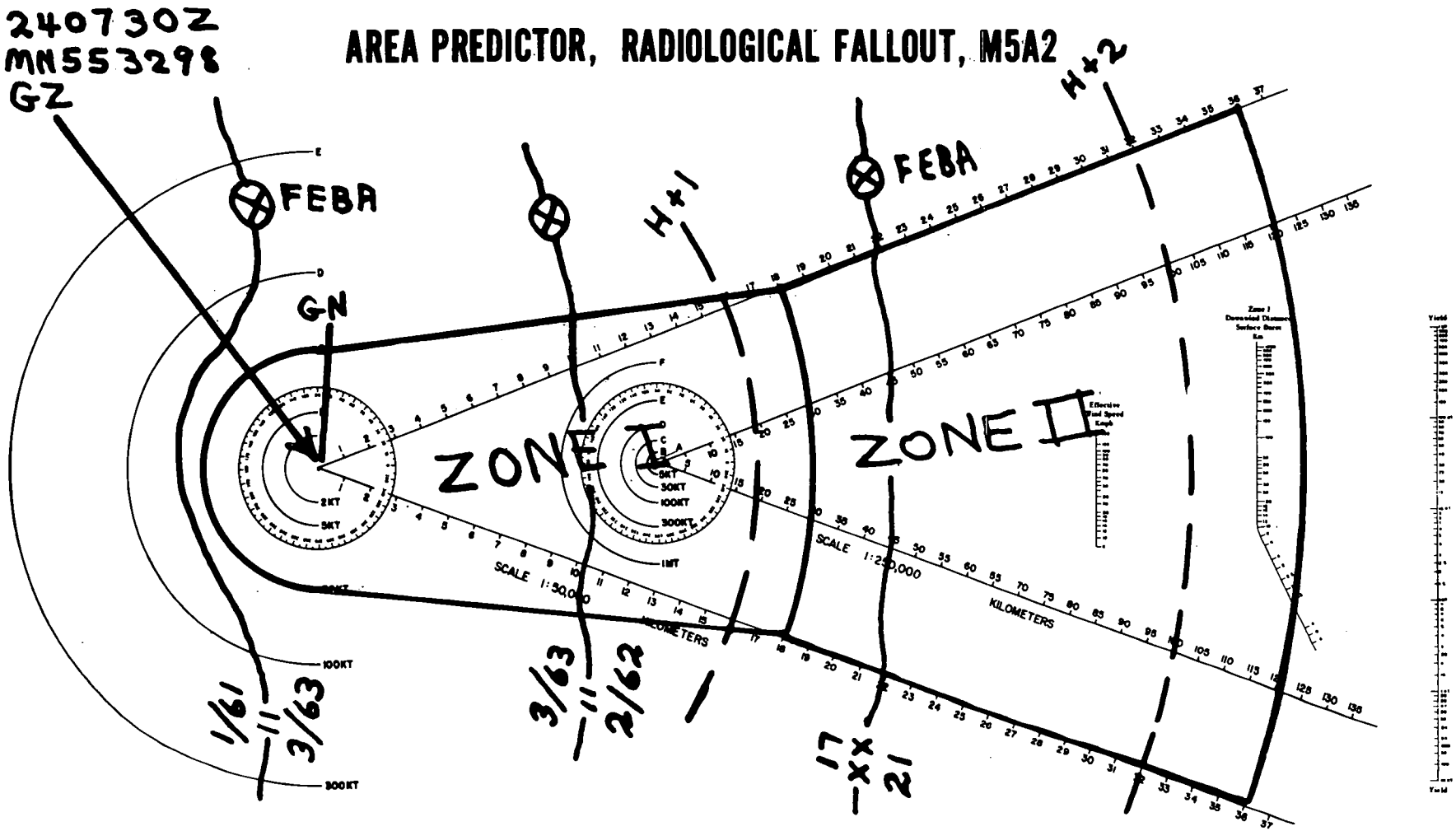


Figure 16. Example problem—Preparation of a simplified fallout prediction for a 16-KT yield burst.

Section II. EFFECTIVE DOWNWIND MESSAGE

35. Calculation of Effective Wind Speed and Downwind Direction

The effective wind speed and downwind direction are calculated from the fallout wind vector plot at the CBRE. This information is transmitted in the form of the effective downwind message each time upper air wind data are received, through channels, to subordinate and adjacent units for use with a simplified fallout predictor. Calculations are made as described below.

a. Step 1. From figure 30, obtain the cloud-top height, cloud-bottom height, two-thirds stem height, and time of fall from cloud bottom for the highest yield in each yield group. These yields are 2 KT, 5 KT, 30 KT, 100 KT, 300 KT, and 1,000 KT.

Yield (KT)	*Cloud-top height (meters)*	*Cloud-bottom height (meters)*	*2/3 stem height (meters)*	*Time of fall from cloud bottom (hours)*
2 (ALFA)	4,900	2,600	1,700	0.88
5 (BRAVO)	7,100	4,400	2,800	1.32
30 (CHARLIE)	11,600	7,700	5,100	2.20
100 (DELTA)	14,400	9,300	6,200	2.60
300 (ECHO)	16,700	11,000	7,400	3.00
1,000 (FOXTROT)	21,600	13,500	9,000	3.50

b. Step 2. Place a sheet of overlay paper over the wind vector plot, and mark a grid north reference line and ground zero. Mark the cloud-top height, cloud-bottom height, and two-thirds stem height for the 2-KT yield (use the values given in step 1). Draw radial lines from ground zero through these three points (fig 17(1)).

Note. If any vector of the wind vector plot ***between*** the two-thirds stem height point and the cloud-top height point falls outside the two radial lines drawn from ground zero through these two points, move either one or both radial lines so as to enclose these outside wind vectors. A radial line that has been shifted will still be understood to have the same nomenclature as the original line before shifting (fig. 11(9)).

c. Step 3. To determine the effective wind speed, measure the distance along the cloud-bottom radial line from ground zero to its intersection with the wind vector plot at the cloud-bottom height point, and divide this distance by the time of fall from the cloud bottom (fig 17(2)). If the effective wind speed is determined to be less than 8 kilometers per hour, the special case applies (para 37).

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

$$= \frac{25 \text{ km}}{0.8 \text{ hr}} = 28.4 \text{ kmph} = 28 \text{ kmph.}^*$$

* Round off to nearest kilometer per hour.

d. Step 4. To determine the effective downwind direction, use a protractor to bisect the angle formed by the cloud-top height radial line and the two-thirds stem height radial line. Measure the azimuth of the bisector in degrees from grid north. This is the effective downwind direction (fig 17(3)).

e. Step 5. Repeat steps 2, 3, and 4 for the remaining yields listed in step 1, using a separate sheet of overlay paper for each yield.

f. Step 6. Prepare the effective downwind message as described in paragraph 30*b*.

g. Step 7. Transmit the effective downwind message to subordinate and adjacent units.

h. Figure 18 is an effective downwind message worksheet that will facilitate the preparation of effective downwind messages at the CBRE as well as provide a means of checking the computations used in the message development. The design of the worksheet permits two shortcuts in the calculations described above.

(1) To determine the effective downwind direction, add the angles and divided by 2. See footnote 1 on the worksheet for exceptions to this shortcut.

(2) To determine the effective wind speed, multiply the distance of the ground zero/cloud-bottom radial line by the reciprocal of the time of fall. See footnote 3 on the worksheet.

36. Calculation of Effective Wind Speed and Downwind Direction

The procedure for preparing the effective downwind message from a constant pressure surface type of wind vector plot varies from the procedure in paragraph 35. The procedure to be used is described below:

a. Step 1. On the constant pressure surface type of wind vector plot (fig 19), draw radial lines from ground zero through the points on the wind vector plot which correspond to the average cloud-bottom heights for the yields of interest. The average altitudes which correspond to the cloud-

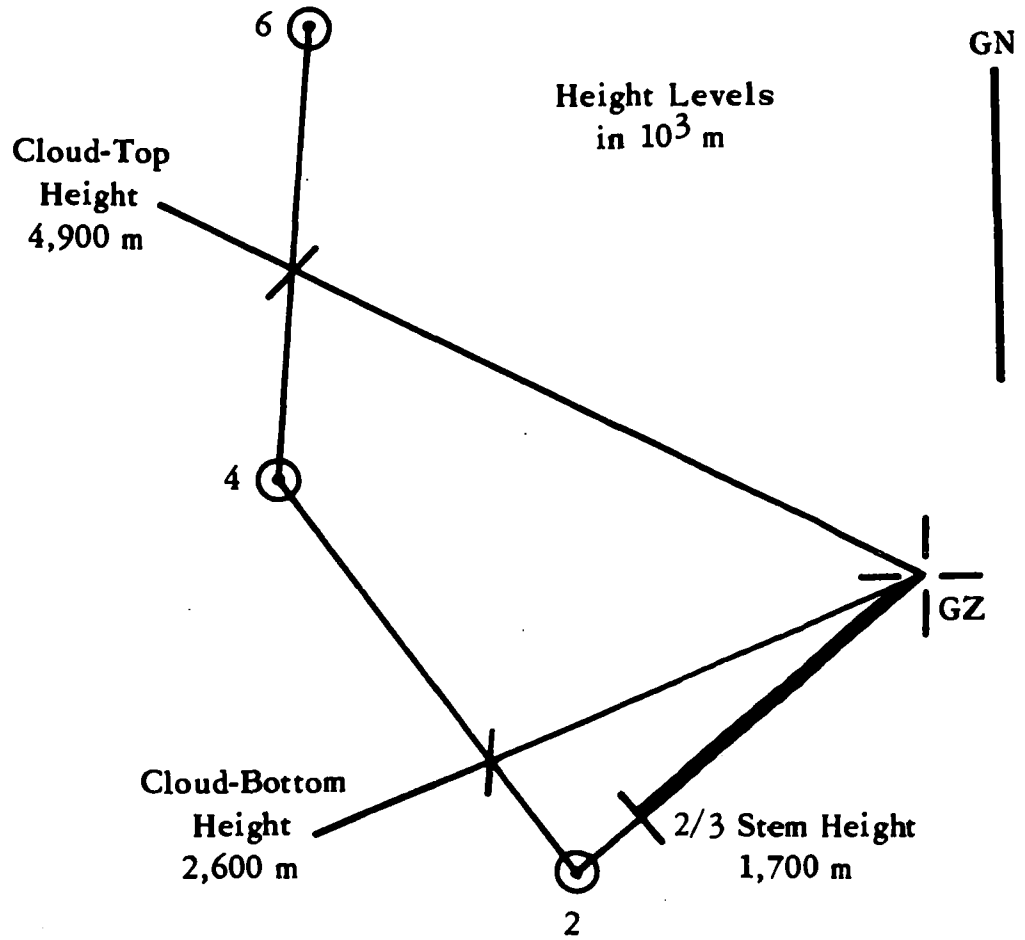


Figure 17(1). Effective wind speed and downwind direction.

bottom heights of the yields used in the simplified prediction method are given below.

Yield (KT)	*Average altitude of cloud-bottom height (ft)*
2 (A)	9,000
5 (B)	14,000
30 (C)	25,000
100 (D	30,000
300 (E)	36,000
1,000 (F)	44,000

b. Step 2. Calculate the effective downwind directions and wind speeds.

(1) Measure the azimuth of each radial line drawn on the constant pressure surface type of wind vector plot which corresponds to a yield and altitude as listed in *a* above. These azimuths are the effective downwind directions for each yield group in this example.

	Yield group	*Azimuth (degrees)*
A	(2 KT or less)	318
B	(2+ to 5 KT)	302
C	(5+ to 30 KT)	289
D	(30+ to 100 KT)	284
E	(100+ to 300 KT)	276
F	(300+ to 1,000 KT)	269

(2) Measure the length in kilometers of each radial line, and divide these distances by the time of fall taken from figure 30. The results are the effective wind speeds, as shown below. Figure 35 may be used to facilitate division operations. To determine times of fall from figure 30, place a straightedge horizontally through the yield of interest on the left and right yield scales, and read the time of fall from cloud bottom.

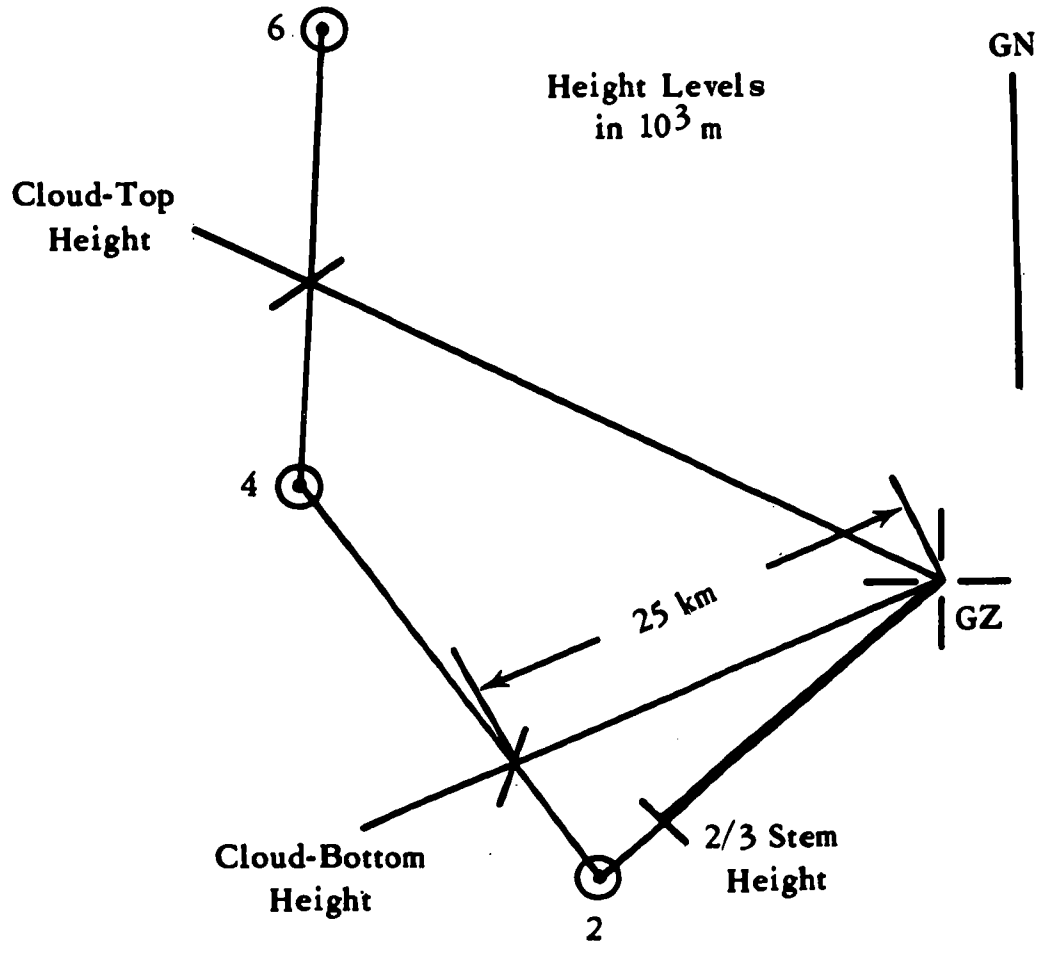


Figure 17(2)—Continued.

Yield group	*Radial distance + from GZ to cloud bottom (km)*	*Time of fall (hr)*	= *Effective wind speed (kmph)**
A (2 KT or less)	24.0	0.88	27
B (2+ to 5 KT)	35.6	1.32	27
C (5+ to 30 KT)	56.0	2.20	25
D (30+ to 100 KT)	64.8	2.60	25
E (100+ to 300 KT)	76.3	3.00	25
F (300+ to 1,000 KT)	92.8	3.50	27

*Round off to nearest kilometer per hour.

c. Step 3. Prepare the effective downwind message, using the data from *b*(1) and (2) above.

Effective Downwind Message

ZULU	301200Z
ALFA	318027
BRAVO	302027
CHARLIE	289025
DELTA	284025
ECHO	276025
FOXTROT	269027

37. Special Cases

a. The situation may arise when the effective wind speed for one or more yield groups is less than 8 kilometers per hour. In this case, determine the downwind distance of Zone I from figure 31 for an effective wind speed of 8 kilometers per hour and the highest yield in the yield group of interest. Record the Zone I downwind distance for the yield group of interest on the appropriate line of the effective downwind message, using three digits. For example, the effective wind speed for line ALFA (2 KT) was determined to be less than 8 kilometers per hour using the procedure described in paragraph 35*c*. Using an effective wind speed of 8 kilometers per hour and a 2-KT yield on figure 31, obtain a Zone I downwind distance of 4.0 kilometers. For line ALFA, record three digits, 004 (see example in *b* below). A di-

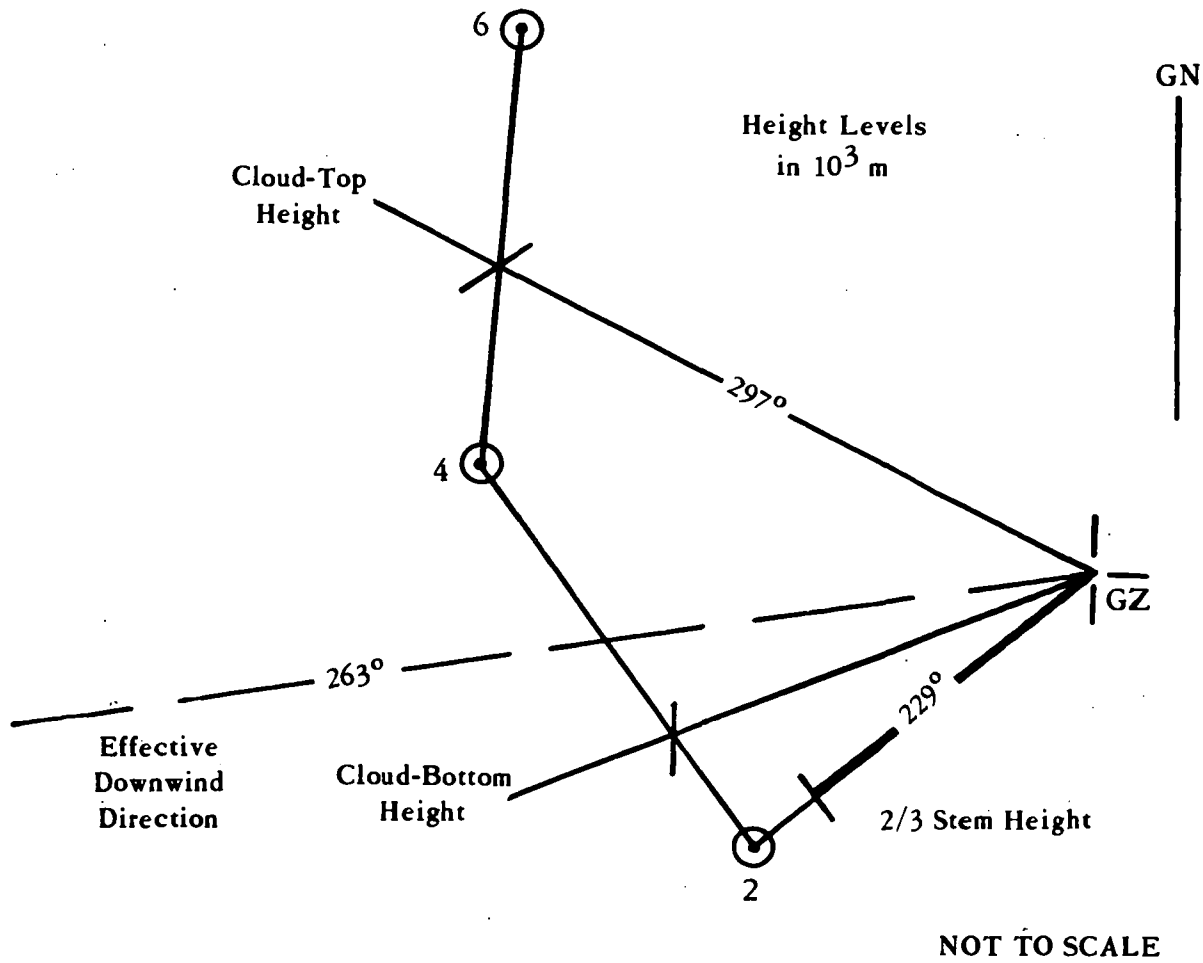


Figure 17(3)—Continued.

rection is not transmitted for the yield group. The militarily significant fallout may, in fact, fall around ground zero in several different directions. The downwind distance, in this case, describes Zone I as a circle around ground zero.

b. There will be instances when the angle between the two-thirds stem height and the cloud-top height is greater than 40 degrees. In these instances, the effective downwind message will indicate, beside the particular line of the message, the greater angle for the applicable yield group. For example:

Effective Downwind Message

ZULU	301200Z
ALFA	004
BRAVO	006
CHARLIE	273038
DELTA	269036 (60)
ECHO	266037
FOXTROT	263037

In the case of line DELTA, the predicted area of fallout will be 30 degrees on either side of the effective downwind direction of 269 degrees.

a. Time of Wind Measurement (dote-time group) D D t t t t _____

Data and Colculations (para 35)

	Message line	Yield (KT)	Cloud-top height (meters)	Cloud-bottom height (meters)	2/3 stem height (meters)	① Azimuth of GZ/CT radial line (degrees)	② Azimuth of GZ/2/3 stem radial line (degrees)	Effective downwind direction–ddd (degrees) $\frac{① + ②}{2} = \frac{\text{sum of } ① \text{ and } ②}{2} = \text{ddd}^1$	③ Distance of GZ/CB radial line (km)	Effective wind speed–sss (kmph) $③ \times \frac{1}{\text{time of fall}^3} = \text{sss}^2$
b.	A	2	4,900	2,600	1,700			$\frac{+}{2} = \frac{}{2} =$		× 1.136 =
c.	B	5	7,100	4,400	2,800			$\frac{+}{2} = \frac{}{2} =$		× 0.758 =
d.	C	30	11,600	7,700	5,100			$\frac{+}{2} = \frac{}{2} =$		× 0.455 =
e.	D	100	14,400	9,300	6,200			$\frac{+}{2} = \frac{}{2} =$		× 0.385 =
f.	E	300	16,700	11,000	7,400			$\frac{+}{2} = \frac{}{2} =$		× 0.333 =
g.	F	1,000	21,600	13,500	9,000			$\frac{+}{2} = \frac{}{2} =$		× 0.286 =

Effective Downwind Messoge

h. ZULU DDtttt ___ ___ ___ ___ ___ ___ (line o)

i. ALFA dddsss ___ ___ ___ ___ ___ ___ (line b)

j. BRAVO dddsss ___ ___ ___ ___ ___ ___ (line c)

k. CHARLIE dddsss ___ ___ ___ ___ ___ ___ (line d)

l. DELTA dddsss ___ ___ ___ ___ ___ ___ (line e)

m. ECHO dddsss ___ ___ ___ ___ ___ ___ (line f)

n. FOXTROT dddsss ___ ___ ___ ___ ___ ___ (line g)

[1]When the azimuth of the ground zero/cloud-top radial line ① or the azimuth of the graund zero/2/3 stem radial line ② falls in the first quadrant (0° to 90°) and the ather falls in the faurth quadrant (270° to 360°), the result of $\frac{① + ②}{2}$ will be the back azimuth of the effective dawnwind direction. In this case, determine ddd by the following method: If result is greater than 180°, subtract 180°; if result is less than 180°, add 180°. Enter in the effective downwind message.

[2]Enter in the effective dawnwind message.

[3]The time of fall is given in paragraph 35a. The multiplying factars are the reciprocals af the time af fall.

Figure 18. Effective downwind message worksheet.

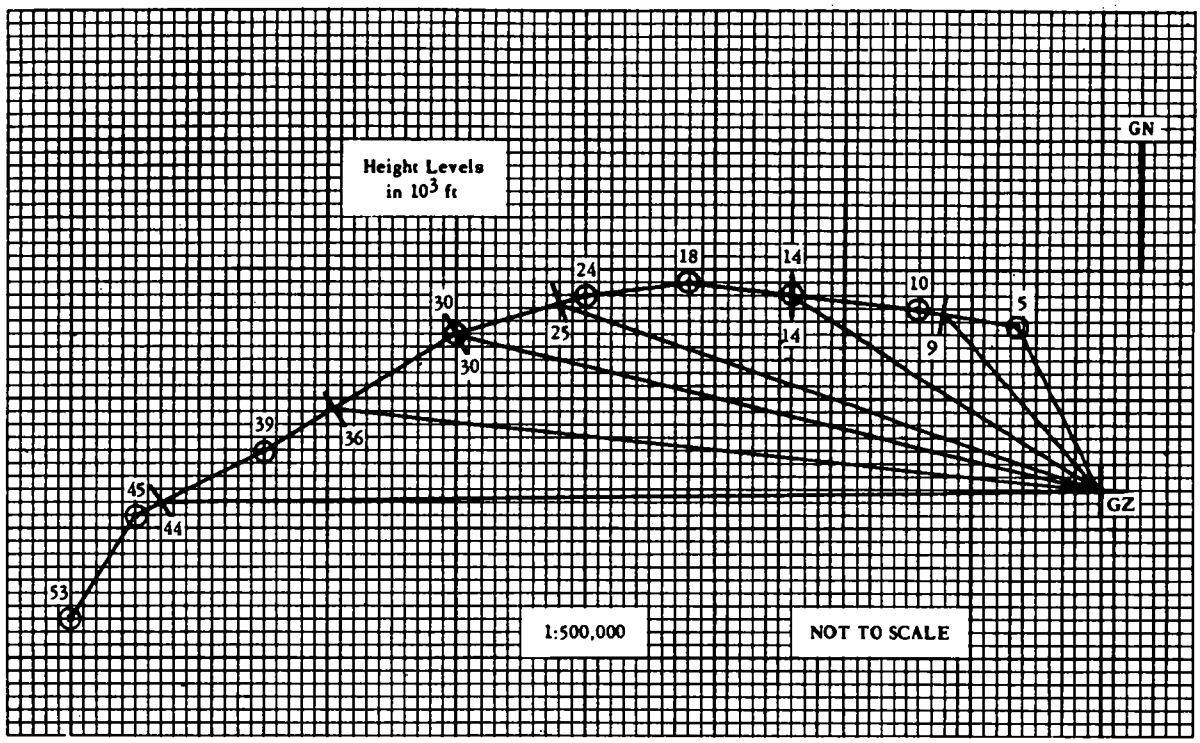


Figure 19. Example of constant pressure surface type of wind vector plot.

CHAPTER 4

FALLOUT PREDICTION FOR ATOMIC DEMOLITION MUNITIONS STANAG 2103, ABCA QSTAG 123)

Section I. INTRODUCTION

38. General

a. This chapter includes modification to the the current detailed fallout prediction method (chap 2), making it suitable for use for predicting the hazard from surface bursts in the atomic demolition munition (ADM) yield range of less than 0.15 KT or of 0.15 KT and higher, and from subsurface bursts of any yield.

b. The procedures in this chapter are designed primarily for the prediction of fallout from friendly bursts. To predict fallout from enemy subsurface bursts, certain assumptions about the yield and depth of burst must be made before these procedures can be applied (para 46).

39. Application

a. Table 6 (chap 6) may be used to determine which of the procedures in this chapter apply to a particular case.

b. A convenient worksheet for recording data for the fallout prediction of all ADM bursts with yields of 0.15 KT or higher, both surface and subsurface, is shown in figure 20.

c. A worksheet for recording data for the fallout prediction of all ADM bursts with yields of less than 0.15 KT, both surface and subsurface, is shown in figure 23.

d. The STRIKWARN message (line w of figure 20 and line t of fig 23) is presented in chapter 5.

Section II. PROCEDURES FOR ADM BURSTS WITH YIELDS OF 0.15 KT OR HIGHER

40. Surface Bursts

The fallout prediction procedure described in chapter 2 will be used for the prediction of fallout from ADM with yields of 0.15 KT or higher which are detonated as surface bursts on or above the surface. Although the techniques are the same as those in chapter 2, the fallout prediction worksheet for ADM bursts with yields of 0.15 KT or higher (fig 20) should be used for recording data so that an accurate record can be maintained by the CBRE.

41. Subsurface Bursts—General Procedures

The detailed fallout prediction method outlined in chapter 2 is modified to account for the subsurface effects when ADM with yields of 0.15 KT or higher are detonated below the surface as subsurface bursts. Depending on the depth of burial, the fallout hazard produced may be of greater or lesser significance than a surface burst. Figure 21 provides the depth scaling factor, f, which is used to make a correction to account for the effects of burial. The depth scaling factor is used in conjunction with figure 22 to provide the correction factor for the downwind distances of Zone I and Zone II. The downwind distance of Zone I is determined from figure 31 (Zone II is twice Zone I). The distances are adjusted, as necessary, by an FY/TY factor from figure 34 and by the zone correction factors.

42. Subsurface Bursts—Detailed Procedures

a. Step 1. Record Data. Enter all known data on lines a through e of the worksheet (fig 20).

b. Step 2. Preparation of Fallout Wind Vector Plot. Prepare the fallout wind vector plot as described in section I of chapter 2. (Refer to the example problems in sec V of chap 2.) The fallout wind vector plot is prepared each time new upper air wind data are received; each prediction made from the current fallout wind vector plot should be prepared on a separate overlay so that the cur-

rent fallout wind vector plot may be saved for further use.

c. Step 3. Determination of Cloud Parameters. Read the cloud parameters from figure 30. Enter figure 30 with the yield, placing a straightedge so that the values on the left yield index scale and on the right yield index scale are the same. Read all parameters under the straightedge, and record on lines f through j of the worksheet.

d. Step 4. Initial Determination of Lateral Limits of the Fallout Prediction. Mark points representing the cloud-top height, cloud-bottom height, and two-thirds stem height on the fallout wind vector plot. Draw radial lines from the ground zero point through these height points (interpolate linearly between the wind vectors if necessary (fig 11(1)). Expand the angle formed by these two radial lines as necessary to include outside wind vectors (para 19*d* and fig 11(9)).

e. Step 5. Determination of the Effective Wind Speed. Measure the length of the radial line, in kilometers, from GZ to the cloud-bottom height point (fig 11(1)). Record this value on line k of the worksheet. Read the time of fall from the cloud bottom from line j of the worksheet. Compute the effective wind speed as shown below and record on line 1 of the worksheet.

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

f. Step 6. Determination of Downwind Distances of Zone I and Zone II.

(1) Enter figure 31 with the effective wind speed and yield, and read the downwind distance of Zone I from the center scale. Record this value on line m of the worksheet. The downwind distance of Zone II is twice that of Zone I.

(2) Calculate the corrected downwind distances of Zones I and II.

(*a*) Enter figure 21 with the yield, and read the depth scaling factor, f. Record on line n of the worksheet.

(*b*) Determine the scaled depth by applying the formula: Scaled depth = f × actual depth. Record on line o of the worksheet.

(*c*) Determine the downwind distance correction factors for Zones I and II from figure 22, using the scaled depth. The dashed line in figure 22 represents the correction factor for Zone II where the two correction factors differ. Record on line p of the worksheet.

(*d*) Determine the adjustment factors for Zones I and II. Obtain the FY/TY adjustment factor from figure 34, or use one. Multiply the correction factors ((*c*) above) by the FY/TY adjustment factor. Record on lines q and r of the worksheet.

(*e*) Multiply the downwind distances of Zones I and II, obtained in (1) above, by the appropriate adjustment factors from lines q and r. Record on lines s and t of the worksheet.

g. Step 7. Construction of the Left and Right Radial Lines.

(1) Measure the angle formed by the radial lines drawn from ground zero to the cloud-top height point and two-thirds stem height point on the fallout wind vector plot (or the radial lines which have been expanded to include vectors between the two-thirds stem height and the cloud-top height). If the angle formed is 40 degrees or greater, proceed as outlined in (2) below. If the angle formed is less than 40 degrees, bisect the angle and expand it to 40 degrees by drawing radial lines at 20 degrees on each side of the bisector (para 28*b*(7) and fig 11(3)).

(2) Measure the azimuths, in mils or degrees from grid north, of the final left and right radial lines. Record on lines u and v of the worksheet (use four digits).

h. Step 8. Completion of the Fallout Prediction.

(1) Locate GZ on an overlay. At the selected map scale, draw a line to represent the effective downwind direction. Draw the radial lines at their proper azimuths to a convenient distance. Mark grid north on this overlay.

(2) Between the two radial lines drawn from ground zero, and using ground zero as center, draw two arcs with radii equal to the Zone I and Zone II downwind distances found in step 6.

(3) Using ground zero as center, draw a circle around ground zero with a radius equal to the cloud radius.

(4) Draw two tangents extending from the ground zero circle to the points of intersection of the two radial lines with the Zone I arc.

(5) Using ground zero as center, indicate the estimated times of arrival of fallout by drawing dashed arcs downwind.

i. Step 9. Preparation of the STRIKWARN

a. Time of Burst (date-time group) _____ DELTA DDtttt (local or ZULU)

b. GZ Coordinates _____ FOXTROT yyzzzzzz

c. FY/TY Ratio (from target analyst for friendly weapons only) _____

d. Depth of Burst (from target analyst for friendly weapons only) _____ meters

e. Yield _____ KT

f. Cloud-top Height (fig. 30) _____ 10^3 meters

g. Cloud-bottom Height (fig. 30) _____ 10^3 meters

h. 2/3 Stem Height (fig. 30) _____ 10^3 meters

i. Stabilized Cloud Radius (fig. 30) _____ ZULU INDIA rrr (km, nearest tenth)

j. Time of Fall from Cloud Bottom (fig. 30) _____ hours

Fallout Wind Veotor Plot (Enter f, g, and h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height.)

k. Radial Line Distance from GZ to CB Height _____ km

l. Effective Wind Speed = $\frac{k \text{ (GZ to CB dist)}}{j \text{ (Time of fall)}}$ = _____ $\frac{km}{hr}$ = _____ ZULU INDIA sss (kmph)

m. Downwind Distance (DWD) of Zone I (Enter fig. 31 with 1 and e.) _____ km

n. Scaled Depth Factor (Enter fig. 21 with e.) _____

o. Scaled Depth _____ × _____ = _____ meters (Line d × line n)

p. Correction Factors for Zone I and Zone II DWD (Enter fig. 22 with o.) _____ Zone I _____ Zone II

q. Adjustment Factor for Zone I (CF from p × FY/TY Factor, obtained using c and e with fig. 34 or use one) _____ × _____ = _____

r. Adjustment Factor for Zone II (CF from p × FY/TY Factor, obtained using c and e with fig. 34 or use one) _____ × _____ = _____

s. Adjusted DWD Zone I (Line q × line m) _____ × _____ = _____ ZULU INDIA xxxx (km, nearest tenth)

t. Adjusted DWD Zone II (Line r × line m) _____ × _____ × 2 = _____ ZULU INDIA yyyy (km, nearest tenth)

u. Azimuth of Left Radial Line _____ YANKEE dddd (mils or degrees)

v. Azimuth of Right Radial Line _____ YANKEE cccc (mils or degrees)

Complete the fallout prediction.

w. ENTRIES FOR STRIKWARN MESSAGE

YANKEE ddddcccc _ _ _ _ _ _ _ _ (Azimuths of radial lines—mils or degrees; from lines u and v)

ZULU INDIA sssxxxxyyyyrrr _

(Effective wind speed, kmph, line 1) (Zone I DWD, nearest tenth of km, line s) (Zone II DWD, nearest tenth of km, line t) (Cloud radius, nearest tenth of km, line l)

Figure 20. Fallout prediction worksheet for all ADM bursts wih yields of 0.15 KT or higher.

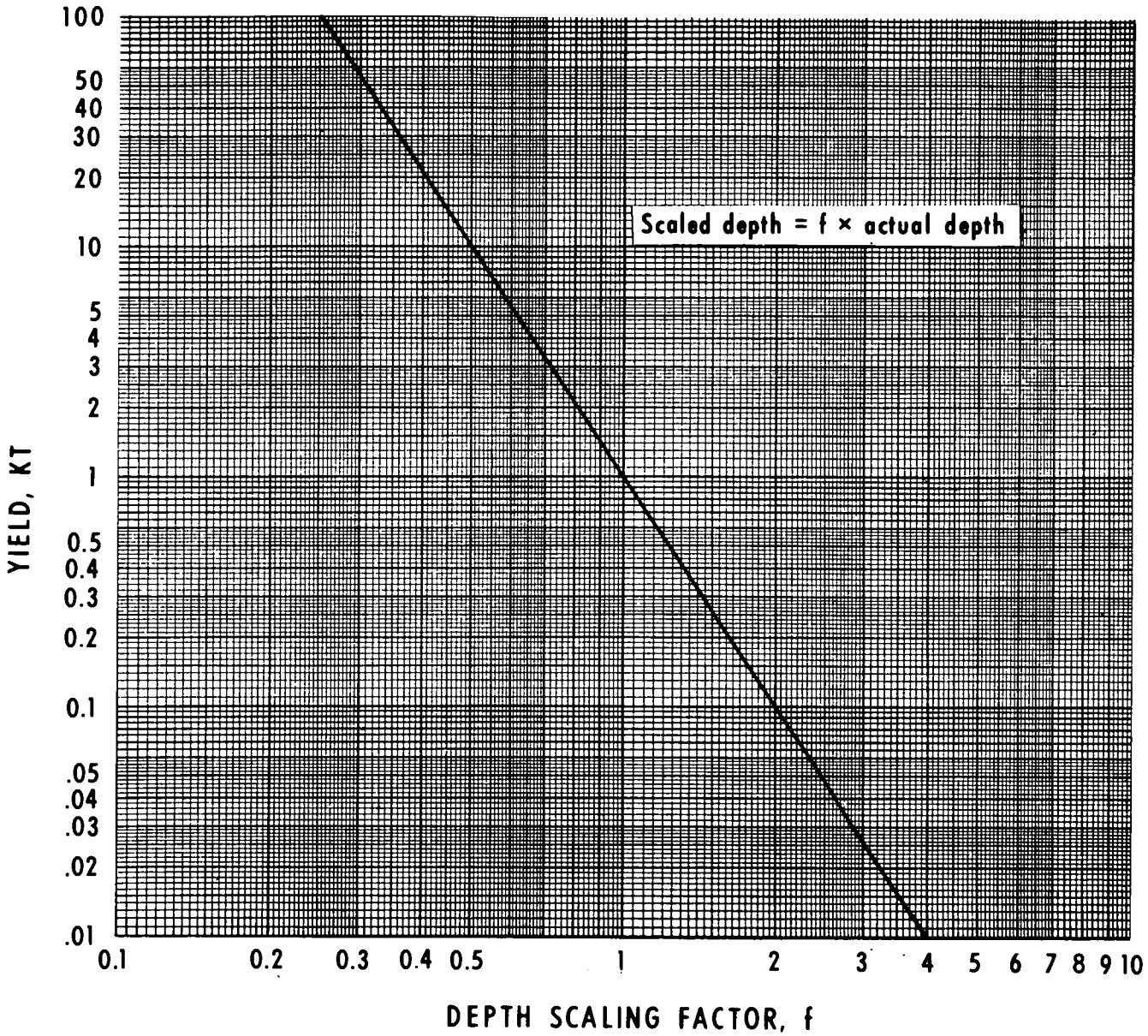


Figure 21. Scaled down factors.

Message. Prepare the STRIKWARN message in the message format in line w of the worksheet, using the calculated data from the appropriate lines of the worksheet.

j. Example Problem. Example problem 1 (para 47) illustrates the preparation of a fallout prediction for a subsurface burst with yield of 0.15 KT or higher.

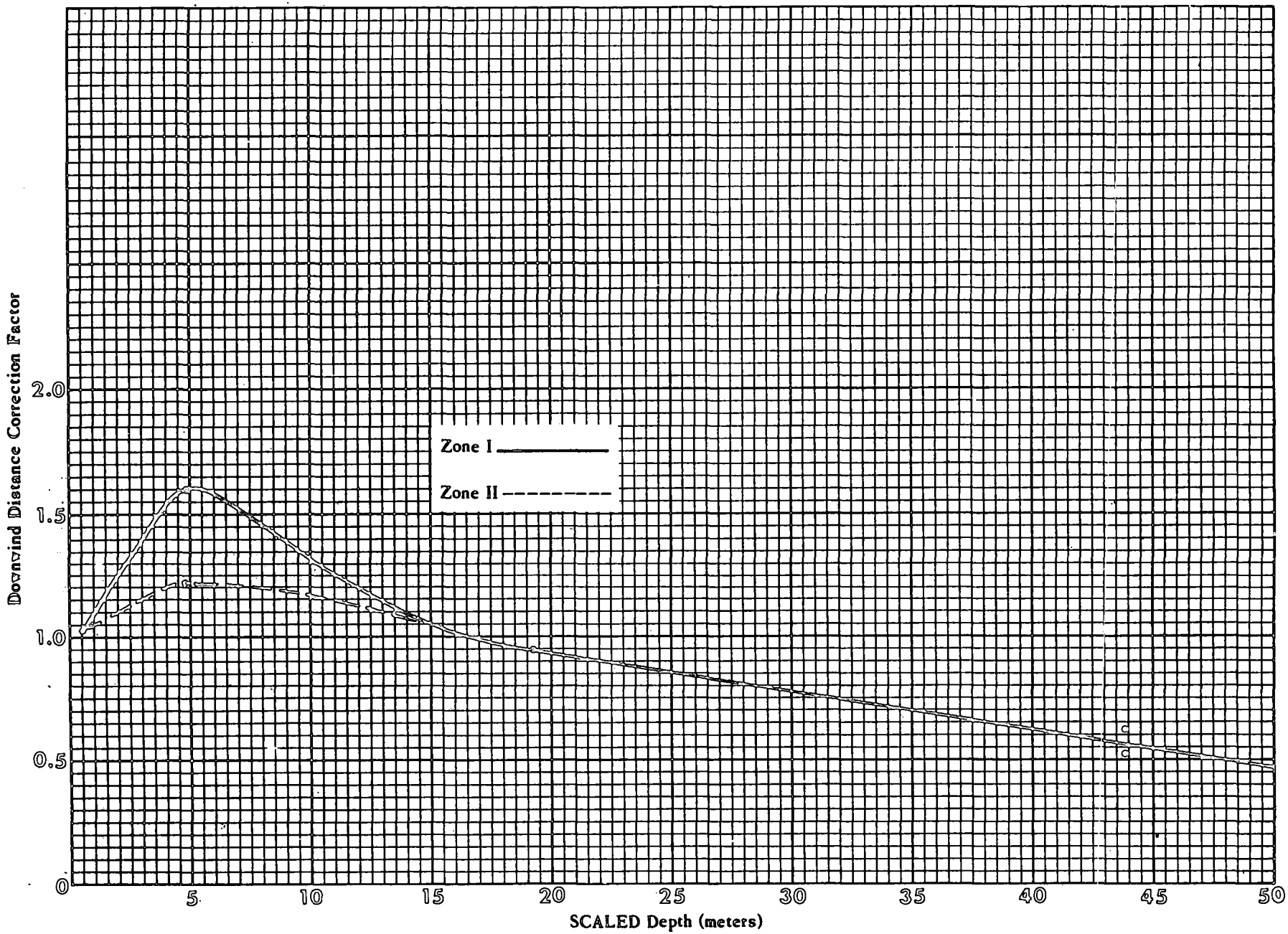


Figure 22. Correction factors for the downwind distances of Zones I and II.

Section III. PROCEDURES FOR ADM BURSTS WITH YIELDS OF LESS THAN 0.15 KT

43. Surface Bursts

A fallout prediction may be prepared, following the procedures outlined below, when ADM with yields of less than 0.15 KT are detonated as surface bursts on or above the surface. The effective downwind direction of the fallout hazard area is the same as the downwind direction of the 0- to 2,000-meter wind layer. Draw the radial lines at 20-degree angles to the left and right of the effective downwind direction. The downwind distance of Zone I is a function of the yield and the wind speed of the 0- to 2,000-meter wind layer. Obtain the effective wind speed (kilometers per hour) by multiplying the wind speed in knots by 1.85. Enter the downwind distance nomogram with the yield and speed of interest and determine the downwind distance of Zone I in kilometers. The downwind distance of Zone II is twice Zone I. For yields of less than 0.15 KT, use 400 meters as the radius of the GZ circle. Use the fallout prediction worksheet for all ADM with yields of less than 0.15 KT (fig 23) to record the data (para 39*b*). Example problem 2 (para 48) illustrates the preparation of a fallout prediction for a surface burst with yield of less than 0.15 KT.

44. Subsurface Bursts—General Procedures

The fallout prediction procedure outlined below takes into account the depth of burial of ADM with yields of less than 0.15 KT. When the detonation is below the surface, use figures 21 and 22 to determine the correction factor for the downwind distances obtained from the downwind distance nomogram. Use the fallout prediction worksheet for all ADM with yields of less than 0.15 KT (fig 23) to record the data.

45. Subsurface Bursts—Detailed Procedures

a. Step 1. Record Data. Record all known data on the worksheet (fig 23). The minimum information necessary to prepare the fallout prediction is the date-time of burst, GZ coordinates, depth of burst yield, and the effective downwind direction and wind speed of the 0- to 2,000-meter wind layer.

b. Step 2. Determination of Lateral Limits of the Fallout Prediction. Draw the left and right radial lines at 20 degrees to the left and right of the effective downwind direction of the 0- to 2,000-meter wind layer (a back azimuth of the raw wind data is necessary). Record on lines f and g of the worksheet.

c. Step 3. Determination of the Effective Wind Speed. Multiply the wind speed (knots) of the 0- to 2,000-meter wind layer (line h of the worksheet) by 1.85 to determine the effective wind speed in kilometers per hour. Enter the effective wind speed on line i of the worksheet.

d. Step 4. Determination of Downwind Distances of Zone I and Zone II.

(1) Determine the downwind distance of Zone I by entering figure 31 with the yield and wind speed of interest. Zone II is twice the downwind distance of Zone I. Record on lines j and k of the worksheet.

(2) Calculate the adjusted downwind distances of Zones I and II.

(*a*) Enter figure 21 with the yield, and read the depth scaling factor, f. Record on line 1 of the worksheet.

(*b*) Determine the scaled depth by applying the formula: Scaled depth = f × actual depth. Record on line m of the worksheet.

(*c*) Determine the downwind distance correction factors for Zones I and II from figure 22, using the scaled depth. Record on line n of the worksheet.

(*d*) Multiply the downwind distances of Zones I and II, obtained in (1) above, by the appropriate correction factors. Record on lines o and p of the worksheet.

(3) The cloud radius is always 0.4 kilometer (400 meters) (line q of the worksheet).

e. Step 5. Determination of Time of Arrival of Fallout. Compute the time of arrival of fallout in minutes at the point of interest or at the end of Zone II by the equation below. Enter on line r.

$$\text{Time of arrival (min)} = \frac{\text{distance from GZ (km)}}{\text{effective wind speed (kmph)}} \times 60 \text{ min}$$

f. Step 6. Preparation of the STRIKWARN Message. Complete the STRIKWARN message in line t from the appropriate lines of the worksheet.

g. Example Problem. Example problem 3 (para 49) outlines the preparation of a fallout prediction for a subsurface burst with yield of less than 0.15 KT.

a. Time of Burst (date-time group) _____ DELTA DDtttt (local or ZULU)

b. GZ Coordinates _____ FOXTROT yyzzzzzz

c. Depth of Burst _____ meters

d. Yield _____ KT

e. Effective Downwind Direction (Use the direction of the plotted 0- to 2,000-meter wind vector. Expand 20 degrees to the left and right of the effective downwind direction.) _____ mils or degrees

f. Azimuth of Left Radial Line _____ YANKEE dddd (mils or degrees)

g. Azimuth of Right Radial Line _____ YANKEE cccc (mils or degrees)

h. Wind Speed (Use the wind speed of the 0- to 2,000-meter wind layer from the upper air wind data report.) _____ knots

i. Effective Wind Speed (Line h × 1.85) _____ ZULU INDIA sss (kmph)

j. Downwind distance (DWD) of Zone I (Enter fig. 31 with d and h.) _____

k. Downwind Distance of Zone II (2 × Line j) _____

For subsurface bursts, complete lines l through n.
For surface bursts, continue at line o.

l. Scaled Depth Factor (Enter fig. 21 with d.) _____

m. Scaled Depth (Line c × 1) _____ × _____ = _____ meters

n. Correction Factors for Zone I and Zone II DWD (Enter fig. 22 with m.) _____ Zone I _____ Zone II

o. Adjusted DWD Zone I _____ × _____ = _____ ZULU INDIA xxxx (km, nearest tenth)
(Line j × line n; or use one for surface burst.)

p. Adjusted DWD Zone II _____ × _____ = _____ ZULU INDIA yyyy (km, nearest tenth)
(Line k × line n; or use one for surface burst.)

q. Cloud Radius is Always 0.4 ZULU INDIA rrr (km, nearest tenth)

r. Time of Arrival of Fallout at End of Zone II (Zone II downwind distance divided by effective wind speed times 60 min/hr) _____ minutes

s. Complete the fallout prediction:
1. Draw two arcs between the radial lines, using GZ as center, with radii equal to the downwind distances from lines o and p.
2. Draw a circle around GZ, using a radius of 400 meters.
3. Draw tangents to the GZ circle and the points of intersection of the two radial lines with the Zone I arc.
4. Plot the time-of-arrival arc, using the data from line r.

t. ENTRIES FOR STRIKWARN MESSAGE

YANKEE ddddcccc _____ _____ _____ _____ _____ _____ _____ _____ (Azimuths of radial lines—mils or degrees; from lines f and g)

ZULU INDIA sssxxxxyyyyrrr _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

(Effective wind speed, kmph, line i) (Zone I DWD, nearest tenth of km, line o) (Zone II DWD, nearest tenth of km, line p) (Cloud radius, nearest tenth of km, line q)

Figure 23. Fallout prediction worksheet for all ADM bursts with yields of less than 0.15 KT

46. Fallout Predictions for Enemy Detonation of ADM

a. Surface Burst. If an enemy ADM detonation is believed to have been a surface burst, use the procedures in paragraph 40 or paragraph 43 for preparation of the fallout prediction.

b. Subsurface Burst. If an enemy ADM detonation is believed to have been a subsurface burst, use an automatic scaled depth of burial of 5 meters; follow the procedures in paragraph 42 or paragraph 45 for preparation of the fallout prediction.

Section IV. EXAMPLE PROBLEMS

47. Example Problem 1. Fallout Prediction for ADM Subsurface Burst With Yield of 0.15 KT or Higher

a. Situation. A 0.3-KT yield ADM is to be detonated 3 meters below the surface of the earth at MN345148 on 070100Z. The effective wind speed has been calculated as 20 kilometers per hour with the effective downwind direction toward 90 degrees. The adjustment factor for fission yield/total yield is 1.

b. Action. Prepare a fallout prediction for the proposed subsurface burst.

(1) *Step 1.* Prepare the fallout prediction, following steps 1 through 5, paragraph 42. Record all data on the worksheet as shown in figure 25.

(2) *Step 2.* Determine the downwind distances of Zone I and Zone II.

(*a*) Enter figure 31 with the effective wind speed and yield, and read the downwind distance of Zone I as 2.1 kilometers. Record on line m of the worksheet. The downwind distance of Zone II is twice that of Zone I, or 4.2 kilometers.

(*b*) Calculate the corrected downwind distances of Zones I and II.

1. Determine the depth scaling factor. Enter figure 21 with the yield (0.3 KT), and read the depth scaling factor, f, as 1.43. Record on line n of the worksheeet.

2. Determine the scaled depth, and record on line o of the worksheet. Apply the formula:

$$\begin{aligned}\text{Scaled depth} &= \text{f} \times \text{actual depth}\\ &= 1.43 \times 3 \text{ meters}\\ &= 4.29 \text{ meters.}\end{aligned}$$

3. Determine the downwind distance correction factors. Enter figure 22 with the scaled depth (4.29 meters), and read a correction factor of 1.57 for Zone I and of 1.2 for Zone II. Record on line p of the worksheet.

4. Determine the adjustment factors for Zones I and II. Multiply the correction factors (*3* above) by the FY/TY adjustment factor (one). Zone I: $1.57 \times 1 = 1.57$; record on line q of the worksheet. Zone II: $1.2 \times 1 = 1.2$; record on line r of the worksheet.

5. Multiply the appropriate adjustment factors (*4* above) by the downwind distances found in (*a*) above. Zone I: 1.57×2.1 kilometers $= 3.3$ kilometers (round to nearest tenth of kilometer); record on line s. Zone II: 1.2×4.2 kilometers $= 5.04$ of 5.0 kilometers (round to nearest tenth of kilometer); record on line t.

(3) *Step 3.* Determine the azimuths of the left and right radial lines (para 42*g*). Record on lines u and v.

(4) *Step 4.* Prepare the fallout prediction plot. Figure 24(1) shows the construction of the plot using a map scale of 1: 50,000.

(*a*) Locate GZ on a piece of overlay paper, and draw a line approximately 8 kilometers in length at 90 degrees from grid north to represent the effective downwind direction. Start at GZ, and draw radial lines at the proper azimuths to the left and right of the effective downwind direction line to approximately 8 kilometers. Usually, the radial lines are at 20 degrees on each side of the effective downwind direction line (para 42*g*).

(*b*) Draw the Zone I downwind distance arc, using GZ as center, with a radius of 3.3 kilometers (line s); draw the Zone II downwind distance arc, using GZ as center, with a radius of 5.0 kilometers (line t).

(*c*) Draw the GZ circle, using GZ as center, with a radius of 500 meters (line i).

(*d*) Draw two tangents from the GZ circle to the points of intersection of the two radial lines with the Zone I arc.

(*e*) Compute the time of arrival of fallout at the outer limits of Zone II.

$$\text{Time of arrival (min)} = \frac{\text{(Zone II distance) 5.0 km}}{\text{(Effective wind speed) 20 kmph}}$$

$$= 0.25 \text{ hour or } 15 \text{ minutes.}$$

Draw the estimated time-of-arrival arc at 5.0 kilometers, and label as H + 15 minutes.

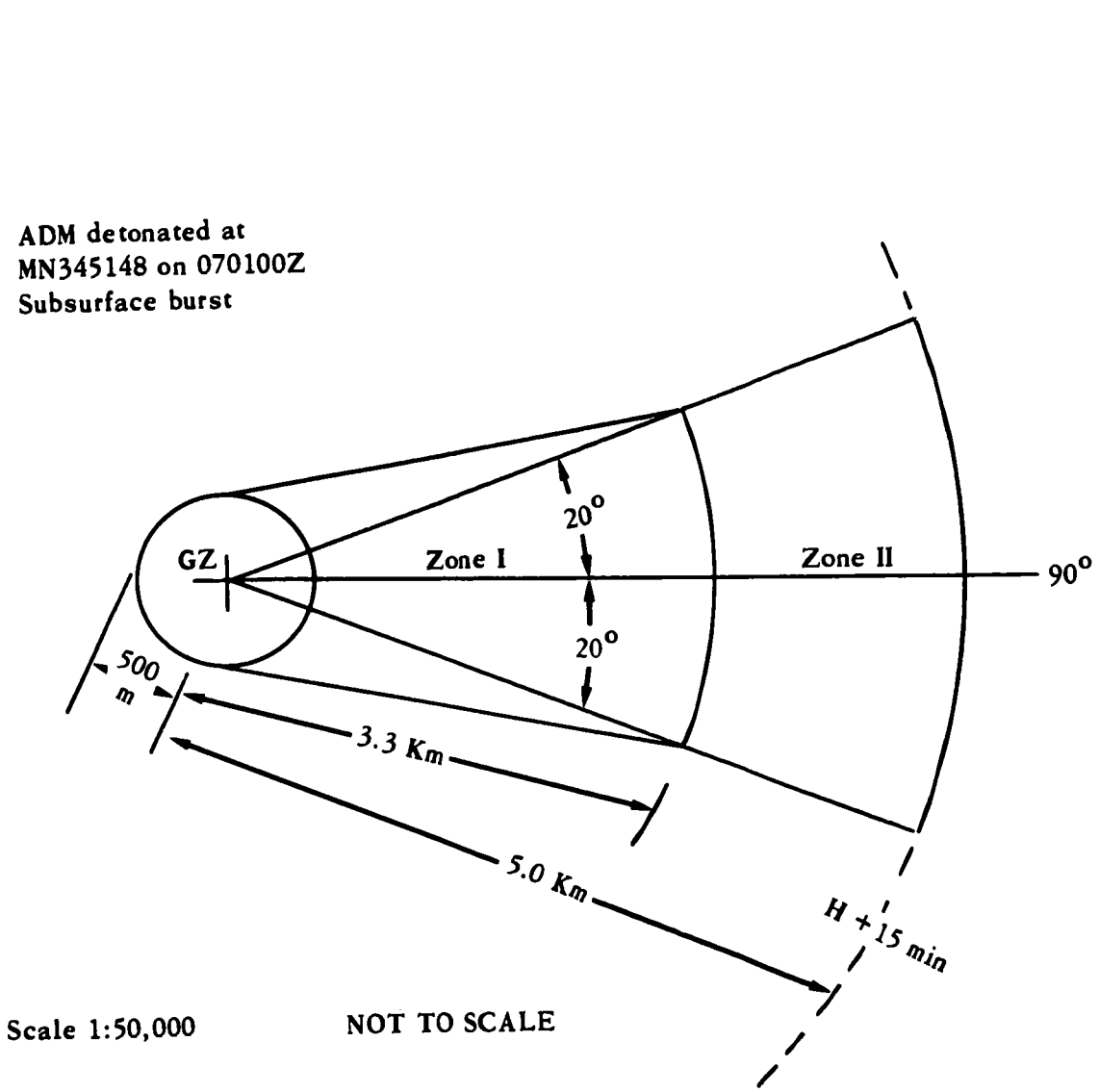


Figure 24(1). Example problem 1—Fallout prediction for ADM subsurface burst with a yield of 0.15 KT or higher.

(*f*) Figure 24(2) shows the completed fallout prediction.

(5) *Step 5.* Prepare and transmit the STRIKWARN message (line w of the worksheet) in accordance with chapter 5.

(6) *Step 6.* Orient the fallout prediction plot. Place the GZ point of the plot over the proposed point of detonation on the map with the GN indicator parallel to a north-south grid line.

48. Example Problem 2. Fallout Prediction for ADM Surface Burst With Yield of Less Than 0.15 KT

a. Situation. A 0.1-KT yield ADM is to be detonated on the surface at PA360198 on 060600Z. The wind speed and direction for the 0- to 2,000-meter wind layer as indicated in the latest meteorological report are 15 knots from 90 degrees.

b. Action. Prepare a fallout prediction for the proposed surface burst. Record all known data on the ADM worksheet for bursts with yields of less than 0.15 KT (fig 23).

(1) *Step 1.* Determine the downwind distance of Zone I. First, determine the wind speed in kilometers per hour (multiply the wind speeed (knots) of the 0- to 2,000-meter layer by 1.85). 15 knots $\times$ 1.85 = 28.0 kilometers per hour. Enter figure 31 with a yield of 0.1 KT and an effective wind speed of 28.0 kilometers per hour and determine the downwind distance of Zone I to be 1.1

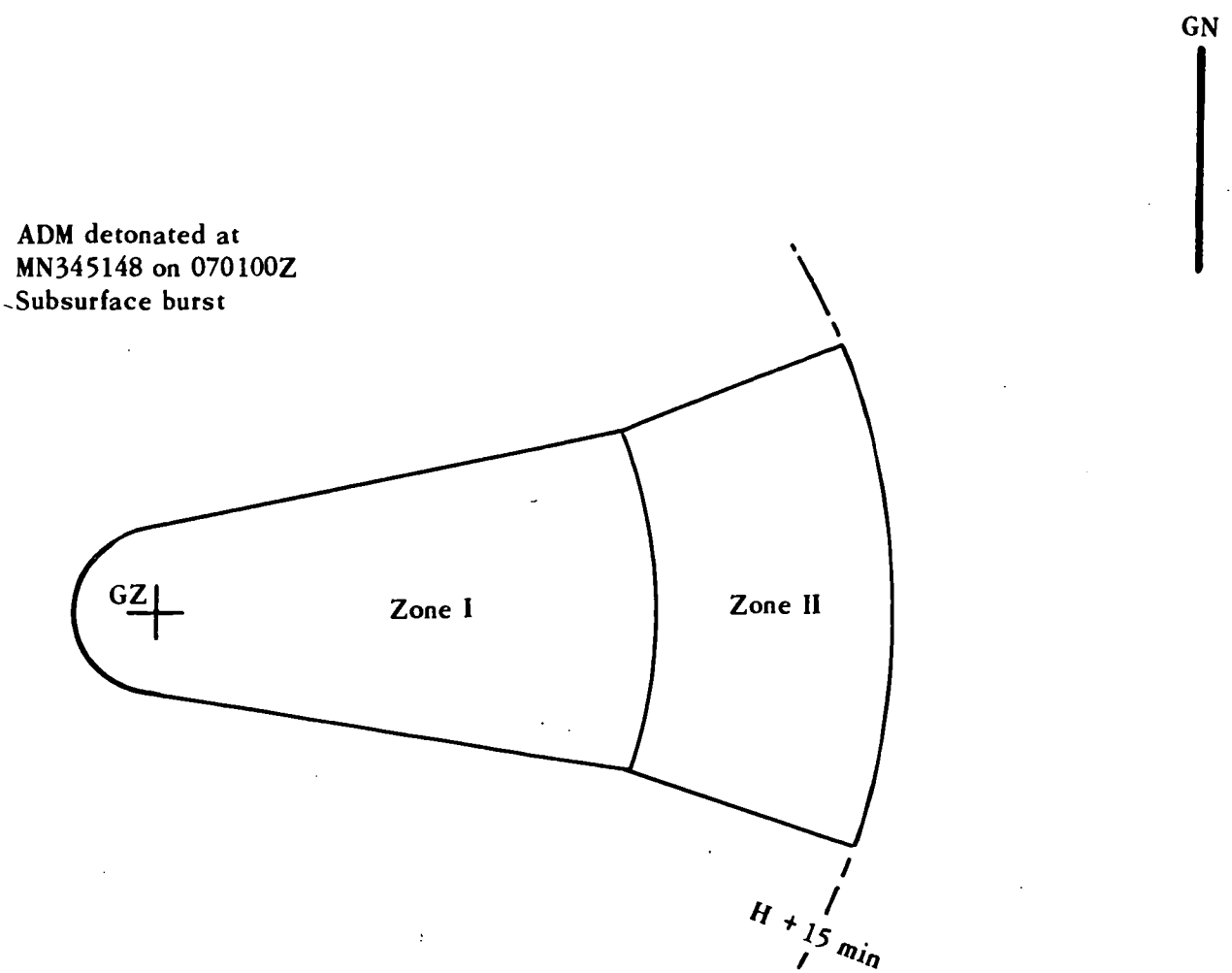


Figure 24(2)—Continued.

kilometers. Record on line j of the worksheet (fig 27).

(2) *Step 2.* Determine the downwind distance of Zone II. The downwind distance of Zone II is 2 times the downwind distance of Zone I. (1.1 × 2 = 2.2 kilometers.) Record on line k of the worksheet.

(3) *Step 3.* Prepare the fallout prediction plot. Figure 26(1) shows the construction of the plot, using a map scale of 1 : 50,000.

(*a*) Locate GZ on a piece of overlay paper, and draw a line approximately 3 kilometers in length at 270 degrees from GN to represent the effective downwind direction. Start at GZ and draw radial lines at 20 degrees to the left and right of the effective downwind direction line to approximately 3 kilometers.

(*b*) Draw the Zone I downwind distance arc, using GZ as center, with a radius of 1.1 kilometers; draw the Zone II downwind distance arc, using GZ as center, with a radius of 2.2 kilometers.

(*c*) Draw the GZ circle, using GZ as center, with a radius of 400 meters (para 43).

(*d*) Draw two tangents from the GZ circle to the points of intersection of the two radial lines with the Zone I arc.

(*e*) Compute the time of arrival of fallout at the outer limits of Zone II. The effective wind speed for the 0- to 2,000-meter wind layer has been calculated as 28.0 kilometers per hour. Record on line i of the worksheet.

$$\text{Time of arrival (min)} = \frac{\text{(Zone II distance) 2.2 km}}{\text{(Effective wind speed) 28.0 kmph}}$$

= .0768 hour or 4.72 minutes.
(0.786 × 60)

a. Time of Burst (date-time group) 070100 DELTA DDtttt (~~local or~~ ZULU)

b. GZ Coordinates MN345148 FOXTROT yyzzzzzz

c. FY/TY Ratio (from target analyst for friendly weapons only) 1

d. Depth of Burst (from target analyst for friendly weapons only) 3 meters

e. Yield 0.3 KT

f. Cloud-top Height (fig. 30) 2.8 10^3 meters

g. Cloud-bottom Height (fig. 30) 1.55 10^3 meters

h. 2/3 Stem Height (fig. 30) 1.05 10^3 meters

i. Stabilized Cloud Radius (fig. 30) 0.5 ZULU INDIA rrr (km, nearest tenth)

j. Time of Fall from Cloud Bottom (fig. 30) 0.50 hours

Fallout Wind Vector Plot (Enter f, g, and h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height.)

k. Radial Line Distance from GZ to CB Height 10.0 km

l. Effective Wind Speed = $\frac{k \text{ (GZ to CB dist)}}{j \text{ (Time of fall)}} = \frac{10.0 \text{ km}}{0.50 \text{ hr}} = 20$ ZULU INDIA sss (kmph)

m. Downwind Distance (DWD) of Zone I (Enter fig. 31 with 1 and e.) 2.1 km

n. Scaled Depth Factor (Enter fig. 21 with e.) 1.43

o. Scaled Depth 3 × 1.43 = 4.29 meters (Line d × line n)

p. Correction Factors for Zone I and Zone II DWD (Enter fig. 22 with o.) 1.57 Zone I; 1.2 Zone II

q. Adjustment Factor for Zone I (CF from p × FY/TY Factor, obtained using c and e with fig. 34 or use one) 1.57 × 1 = 1.57

r. Adjustment Factor for Zone II (CF from p × FY/TY Factor, obtained using c and e with fig. 34 or use one) 1.2 × 1 = 1.2

s. Adjusted DWD Zone I (Line q × line m) 1.57 × 2.1 = 3.3 ZULU INDIA xxxx (km, nearest tenth)

t. Adjusted DWD Zone II (Line r × line m) 1.2 × 2.1 × 2 = 5.0 ZULU INDIA yyyy (km, nearest tenth)

u. Azimuth of Left Radial Line 0070 YANKEE dddd (~~mils or~~ degrees)

v. Azimuth of Right Radial Line 0110 YANKEE cccc (~~mils or~~ degrees)

Complete the fallout prediction.

w. ENTRIES FOR STRIKWARN MESSAGE

YANKEE ddddcccc 0 0 7 0 0 1 1 0 (Azimuths of radial lines—~~mils or~~ degrees; from lines u and v)

ZULU INDIA sssxxxxyyyyrrr 0 2 0 0 0 3 3 0 0 5 0 0 0 5

(Effective wind speed, kmph, line l) (Zone I DWD, nearest tenth of km, line s) (Zone II DWD, nearest tenth of km, line t) (Cloud radius, nearest tenth of km, line i)

Figure 25. Fallout prediction worksheet for ADM subsurface burst with a yield of 0.15 KT or higher (completed for example problem 1).

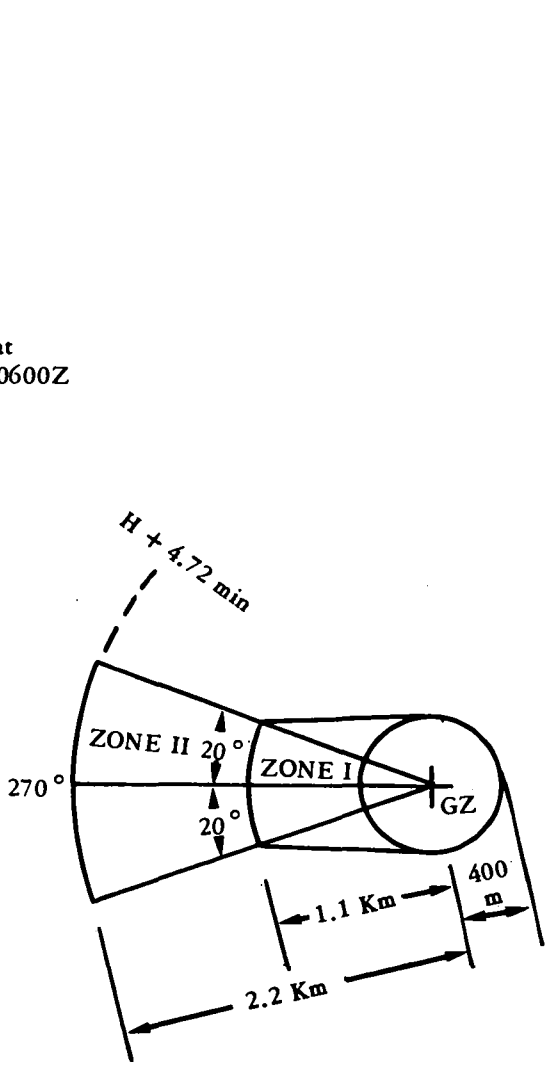


Figure 26(1). Example problem 2—Fallout prediction for ADM surface burst with a yield of less than 0.15 KT.

Record on line r of the worksheet. Draw the estimated time-of-arrival arc at 2.2 kilometers, and label as H + 4.72 minutes.

(*f*) Figure 26(2) shows the completed fallout prediction.

(4) *Step 4.* Prepare and transmit the STRIKWARN message (line t on the worksheet) in accordance with chapter 5.

(5) *Step 5.* Orient the fallout prediction plot. Place the GZ point of the plot over the proposed point of detonation on the map with the GN indicator parallel to a north-south grid line.

49. Example Problem 3. Fallout Prediction for ADM Subsurface Burst With Yield of Less Than 0.15 KT

a. Situation. A 0.05-KT yield ADM is to be detonated 10 meters underground at PA360198 on 060600Z. The current meteorological report is as follows:

Wind layer (meters)	*Wind direction (degrees)*	*Wind speed (knots)*
0–2,000	90	15
2,000–4,000	100	14
4,000–6,000	80	13

b. Action. Prepare the STRIKWARN message

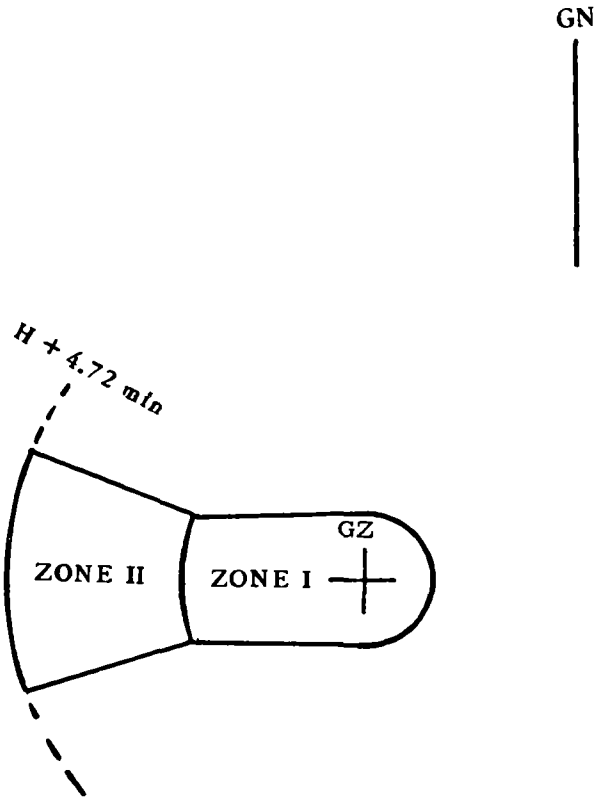


Figure 26 (2)—Continued.

for the above situation from the fallout prediction data.

(1) *Step 1.* Record all known data on the worksheet for ADM bursts with yields of less than 0.15 KT. Figure 28 illustrates the completed worksheet. The effective downwind direction is the back azimuth of the direction of the 0- to 2,000-meter wind layer—270 degrees.

(2) *Step 2.* Determine the azimuths of the left and right radial lines to be at 20 degrees on each side of the effective downwind direction. The left radial line is at 250 degrees and the right at 290 degrees. Record on lines f and g of the worksheet.

(3) *Step 3.* Determine the effective wind speed as 28.0 kilometers per hour by multiplying 15 knots by 1.85. Record on line i.

(4) *Step 4.* Determine the downwind distances of Zones I and II.

(*a*) Enter figure 41 with a yield of 0.05 KT and a windspeed of 28.0 kilometers per hour and determine the downwind distance of Zone I to be 0.5 kilometer. Downwind distance of Zone II = 2 times the distance of Zone I. (2 × 0.5 = 1.0.) Record on lines j and k.

(*b*) Calculate the adjusted downwind distances of Zones I and II.

1. Determine the scaled depth factor from figure 21 to be 2.5. Record on line 1 of the worksheet.

2. Determine the scaled depth by multiplying the scaled depth factor by the actual depth: 2.5 × 10 meters = 25 meters. Record on line m.

3. Enter figure 22 with the scaled depth, and read the correction factors for both Zone I and Zone II to be 0.85. Record on line n.

4. Multiply the downwind distances by the correction factor: Zone I: 0.5 km × 0.85 = 0.425 km or 0.4 kilometer (round to nearest tenth of kilometer). Zone II: 1.0 kilometer × 0.85 = 0.85 km or 0.9 kilometer (round to nearest tenth of kilometer). If the downwind distance falls exactly halfway between tenths of a kilometer, round up. Record on lines o and p.

a. Time of Burst (date-time group) — 060600 — DELTA DDtttt (~~local or~~ ZULU)

b. GZ Coordinates — PA360198 — FOXTROT yyzzzzzz

c. Depth of Burst — 0 — meters

d. Yield — 0.1 — KT

e. Effective Downwind Direction (Use the direction of the plotted 0- to 2,000-meter wind vector. Expand 20 degrees to the left and right of the effective downwind direction.) — 270 — ~~mils or~~ degrees

f. Azimuth of Left Radial Line — 250 — YANKEE dddd (~~mils or~~ degrees)

g. Azimuth of Right Radial Line — 290 — YANKEE cccc (~~mils or~~ degrees)

h. Wind Speed (Use the wind speed of the 0- to 2,000-meter wind layer from the upper air wind data report.) — 15 — knots

i. Effective Wind Speed (Line h × 1.85) — 28 — ZULU INDIA sss (kmph)

j. Downwind distance (DWD) of Zone I (Enter fig. 31 with d and h.) — 1.1 — km

k. Downwind Distance of Zone II (2 × Line j) — 2.2 — km

For subsurface bursts, complete lines l through n.
For surface bursts, continue at line o.

l. Scaled Depth Factor (Enter fig. 21 with d.) — _____

m. Scaled Depth (Line c × 1) — _____ × _____ = _____ meters

n. Correction Factors for Zone I and Zone II DWD (Enter fig. 22 with m.) — _____ Zone I; _____ Zone II

o. Adjusted DWD Zone I (Line j × line n; or use one for surface burst.) — 1.1 × 1 = 1.1 — ZULU INDIA xxxx (km, nearest tenth)

p. Adjusted DWD Zone II (Line k × line n; or use one for surface burst.) — 2.2 × 1 = 2.2 — ZULU INDIA yyyy (km, nearest tenth)

q. Cloud Radius is Always — 0.4 — ZULU INDIA rrr (km, nearest tenth)

r. Time of Arrival of Fallout at End of Zone II (Zone II downwind distance divided by effective wind speed times 60 min/hr) — 4.72 — minutes

s. Complete the fallout prediction:
1. Draw two arcs between the radial lines, using GZ as center, with radii equal to the downwind distances from lines o and p.
2. Draw a circle around GZ, using a radius of 400 meters.
3. Draw tangents to the GZ circle and the points of intersection of the two radial lines with the Zone I arc.
4. Plot the time-of-arrival arc, using the data from line r.

t. ENTRIES FOR STRIKWARN MESSAGE

YANKEE ddddcccc 02500290 (Azimuths of radial lines ~~mils or~~ degrees; from lines f and g)

ZULU INDIA sssxxxxyyyyrrr 028 0011 0022 004

(Effective wind speed, kmph, line l)	(Zone I DWD, nearest tenth of km, line o)	(Zone II DWD, nearest tenth of km, line p)	(Cloud radius, nearest tenth of km, line q)
028	0011	0022	004

Figure 27. Fallout prediction worksheet for ADM surface burst with a yield of less than 0.15 KT (completed for example problem 2).

a. Time of Burst (date-time group) — 060600 — DELTA DDtttt (~~local or~~ ZULU)

b. GZ Coordinates — PA360198 — FOXTROT yyzzzzzz

c. Depth of Burst — 10 — meters

d. Yield — 0.05 — KT

e. Effective Downwind Direction (Use the direction of the plotted 0- to 2,000-meter wind vector. Expand 20 degrees to the left and right of the effective downwind direction.) — 270 — ~~mils or~~ degrees

f. Azimuth of Left Radial Line — 0250 — YANKEE dddd (~~mils or~~ degrees)

g. Azimuth of Right Radial Line — 0290 — YANKEE cccc (~~mils or~~ degrees)

h. Wind Speed (Use the wind speed of the 0- to 2,000-meter wind layer from the upper air wind data report.) — 15 — knots

i. Effective Wind Speed (Line h × 1.85) — 028 — ZULU INDIA sss (kmph)

j. Downwind distance (DWD) of Zone I (Enter fig. 31 with d and h.) — 0.5 — km

k. Downwind Distance of Zone II (2 × Line j) — 1.0 — km

For subsurface bursts, complete lines l through n.
For surface bursts, continue at line o.

l. Scaled Depth Factor (Enter fig. 21 with d.) — 2.5

m. Scaled Depth (Line c × l) — 10 × 2.5 = 25 — meters

n. Correction Factors for Zone I and Zone II DWD (Enter fig. 22 with m.) — 0.85 Zone I; 0.85 Zone II

o. Adjusted DWD Zone I (Line j × line n; or use one for surface burst.) — 0.5 × 0.85 = 0.4 — ZULU INDIA xxxx (km, nearest tenth)

p. Adjusted DWD Zone II (Line k × line n; or use one for surface burst.) — 1.0 × 0.85 = 0.9 — ZULU INDIA yyyy (km, nearest tenth)

q. Cloud Radius is Always — 0.4 — ZULU INDIA rrr (km, nearest tenth)

r. Time of Arrival of Fallout at End of Zone II (Zone II downwind distance divided by effective wind speed times 60 min/hr) — 1.93 — minutes

s. Complete the fallout prediction:
1. Draw two arcs between the radial lines, using GZ as center, with radii equal to the downwind distances from lines o and p.
2. Draw a circle around GZ, using a radius of 400 meters.
3. Draw tangents to the GZ circle and the points of intersection of the two radial lines with the Zone I arc.
4. Plot the time-of-arrival arc, using the data from line r.

t. ENTRIES FOR STRIKWARN MESSAGE

YANKEE ddddcccc 02500290 (Azimuths of radial lines—~~mils or~~ degrees; from lines f and g)

ZULU INDIA sssxxxxyyyyrrr 028 0004 0009 004

(Effective wind speed, kmph, line i) (Zone I DWD, nearest tenth of km, line o) (Zone II DWD, nearest tenth of km, line p) (Cloud radius, nearest tenth of km, line q)

Figure 28. Fallout prediction worksheet for ADM subsurface burst with a yield of less than 0.15 KT (completed for example problem 3).

(5) *Step 5.* Calculate the time of arrival of fallout at the end of Zone II as shown below. Record on line r.

$$\frac{\text{(Zone II downwind distance) 0.9 km}}{\text{(Effective wind speed) 28.0 kmph}} = .0322 \text{ hour}$$

= 1.93 minutes (.0322 × 60).

(6) *Step 6.* Prepare the STRIKWARN message in line t of the worksheet, and disseminate in accordance with chapter 5.

CHAPTER 5

FRIENDLY NUCLEAR STRIKE WARNING MESSAGE (STANAG 2104, ABCA QSTAG 130)

50. General

a. Advance warning of a nuclear strike is required to insure that friendly forces are aware of potential casualty-producing weapons effects (STANAG 2104). The nuclear strike warning message is used for this purpose and is disseminated as rapidly as possible to affected units, using a FLASH precedence.

b. Warning of impending strikes will be initiated no earlier than is necessary to complete warning of personnel. Any available means of communication—land lines if possible—will be utilized to insure that all personnel requiring warning are notified.

c. When nuclear strikes are canceled, units previously warned will be notified in the clear by the most expeditious means in the following format:

(1) Code Word (Target Number)
(2) CANCELED.

d. Items DELTA and FOXTROT below will be sent in the clear only when the time of initiating the warning message is such that no loss of security is involved, and when their passage in clear language is essential to troop safety. Only coding systems which meet NATO security criteria will be used.

51. Format for Transmitting Data

a. The format presented in this paragraph will be used at corps level and below. This applies to surface-to-surface and air-to-surface strikes in support of ground forces, and to emplaced atomic demolition munitions (ADM).

b. The STRIKWARN message contains the following information:

	STRIKWARN
ALFA:	Code word indicating nuclear strike (target number).
DELTA:	Date/time group of burst and date/time group after which the strike will be canceled (both in ZULU time).
FOXTROT:	GZ or DGZ (UTM grid coordinates with a minimum of six numerical figures).
HOTEL:	Indicate air, surface, or subsurface burst.
INDIA:	For all bursts: MSD 1 in hundreds of meters, four digits (Warned protected, negligible risk). MSD 2 in hundreds of meters, four digits (Warned exposed, negligible risk). MSD 3 in hundreds of meters, four digits (Unwarned exposed, negligible risk). LSD for light aircraft in flight for hundreds of meters, four digits.
YANKEE:	For all bursts when there is less than a 99 percent assurance of no militarily significant fallout. Azimuth of left than right radial lines (degrees or mils—state which), four digits each.
ZULU:	For bursts 0.15 KT, or greater, (except subsurface bursts) when there is less than 99 percent assurance of no militarily significant fallout. Effective wind speed in kilometers per hour to nearest kilometer, three digits. Downwind distance to Zone I to nearest kilometer, three digits. Cloud radius to nearest kilometer, two digits. (Use of the ZULU line precludes use of the ZULU INDIA line.) *Note.* If effective wind speed is less than 8 kmph, line ZULU will contain only three significant digits, i.e., the radius of Zone I.
ZULU INDIA:	For bursts less than 0.15 KT and for all subsurface bursts. Effective wind speed in kilometers per hour to nearest kilometer, three digits. Downwind distance of Zone I in hundreds of meters, four digits. Downwind distance of Zone # in hundreds of meters, four digits. Cloud radius in hundreds of meters, three digits. (Use of the ZULU INDIA line precludes use of the ZULU line.) *Note.* If effective wind speed is less than 8 kmph, line ZULU INDIA will contain only four significant digits, i.e., the radius of Zone I.

CHAPTER 6

TABLES, GRAPHS, AND NOMOGRAMS USED IN FALLOUT PREDICTION (STANAG 2103, ABCA QSTAG 123)

52. General

The tables, graphs, and nomograms used in the preparation of fallout predictions are grouped in this section for the convenience of the user.

53. Purpose

These tables, graphs, and nomograms are referenced throughout the manual as their purpose is established.

Table 1. Mils to Degrees Conversion Table

Mils	Degrees	Mils	Degrees
0	0	3,300	186
100	6	3,400	191
200	11	3,500	197
300	17	3,600	203
400	23	3,700	208
500	28	3,800	214
600	34	3,900	220
700	40	4,000	225
800	45	4,100	231
900	51	4,200	237
1,000	57	4,300	242
1,100	62	4,400	247
1,200	67	4,500	253
1,300	73	4,600	259
1,400	79	4,700	264
1,500	84	4,800	270
1,600	90	4,900	276
1,700	96	5,000	281
1,800	101	5,100	287
1,900	107	5,200	293
2,000	113	5,300	298
2,100	118	5,400	304
2,200	124	5,500	310
2,300	130	5,600	315
2,400	135	5,700	321
2,500	141	5,800	327
2,600	147	5,900	332
2,700	152	6,000	337
2,800	157	6,100	343
2,900	163	6,200	349
3,000	169	6,300	354
3,100	174	6,400	360
3,200	180		

*Table 2. Distance Conversion Table**

To convert—	*To—*	*Multiply by—*
kilometers	miles	0.62
kilometers	nautical miles	.54
miles	kilometers	1.61
miles	nautical miles	.87
nautical miles	kilometers	1.85
nautical miles	miles	1.15

*The same conversion factors are used when changing one velocity to another in a different units system. *Note* that 1 knot is equal to 1 nautical mile per hour.

Table 3. Weighting Factors for 2,000-Meter Wind Layers (to be used with U S Army field artillery wind data)

Wind layer (10^2 meters)	Time in layer (hours)	Weighting factor (multiply wind speed in knots by this factor to get kilometers)
0–2	0.68	1.26
2–4	.59	1.09
4–6	.52	.96
6–8	.50	.93
8–10	.48	.89
10–12	.45	.83
12–14	.42	.78
14–16	.40	.74
16–18	.39	.72
18–20	.38	.70
20–22	.37	.69
22–24	.36	.67
24–26	.36	.67
26–28	.35	.65
28–30	.34	.63
30–32	.34	.63
32–34	.33	.61
34–36	.33	.61
36–38	.32	.59
38–40	.31	.57
40–42	.31	.57
42–44	.30	.55
44–46	.30	.55
46–48	.29	.54
48–50	.29	.54

Table 4. Weighting Factors and Plotting Scale Data for 5,000-Foot Wind Layers (to be used with Air Weather Service wind data)

Wind layer (10^3 feet)	Time in layer (hours)	Weighting factor (multiply wind speed in knots hy this factor to get kilometers)	Plotting scale slot (to he used with the wind layer that is indicated)	Adjustment factor (multiply reported wind speed hy this factor before plotting)
0–5	0.51	0.94	6–8	1
5–10	.46	.85	10–12	1
10–15	.43	.80	12–14	1
15–20	.41	.76	14–16	1
20–25	.39	.72	16–18	1
25–30	.37	.68	20–22	1
30–35	.35	.65	26–28	1
35–40	.34	.62	28–30	1
40–45	.32	.59	28–30	1
45–50	.31	.57	2–4	½
50–55	.30	.56	2–4	½
55–60	.30	.56	2–4	½
60–65	.29	.54	2–4	½
65–70	.28	.52	2–4	½
70–75	.28	.52	2–4	½
75–80	.27	.50	4–6	½
80–85	.27	.50	4–6	½
85–90	.27	.50	4–6	½
90–95	.27	.50	4–6	½
95–100	.26	.48	4–6	½
100–105	.24	.44	6–8	½
105–110	.24	.44	6–8	½
110–115	.24	.44	6–8	½
115–120	.23	.43	6–8	½
120–125	.23	.43	6–8	½
125–130	.23	.43	6–8	½
130–135	.22	.41	8–10	½
135–140	.22	.41	8–10	½
140–145	.22	.41	8–10	½
145–150	.21	.39	12–14	½
150–155	.21	.39	12–14	½
155–160	.21	.39	12–14	½

Table 5. Weighting Factors and Plotting Scale Data (to be used with Air Weather Service constant pressure surface winds)

Constant pressure aurface (millibars)	Wind layer (10^3 feet)	Weighting factor (multiply wind speed in knots by this factor to get kilometers)	Plotting acale slot (to be used with the wind layer that is indicated)	Adjustment factor (multiply reported wind speed by this factor before plotting)
850	0–5	0.94	6–8	1
700	5–10	.85	8–10	1
600	10–14	.63	Above 26	1
500	14–18	.57	2–4	½
400	18–24	.82	10–12	1
300	24–30	.82	10–12	1
200	30–39	1.15	2–4	1
150	39–45	.74	14–16	1
100	45–53	.93	6–8	1

Table 6. References for ADM Fallout Prediction Procedures

Yield	*Surface bursts*	*Subsurface bursts*
≥0.15 KT	Para 39, 40, 46; fig 20.	Para 39, 41, 42, 46, 47; figs 20–22, 24(1), 24(2), 25, 30, 31, 34.
<0.15 KT	Para 39, 43, 46, 48; figs 23, 26(1), 26(2), 27, 31.	Para 39, 44–46, 49; figs 21–23, 28, 31.

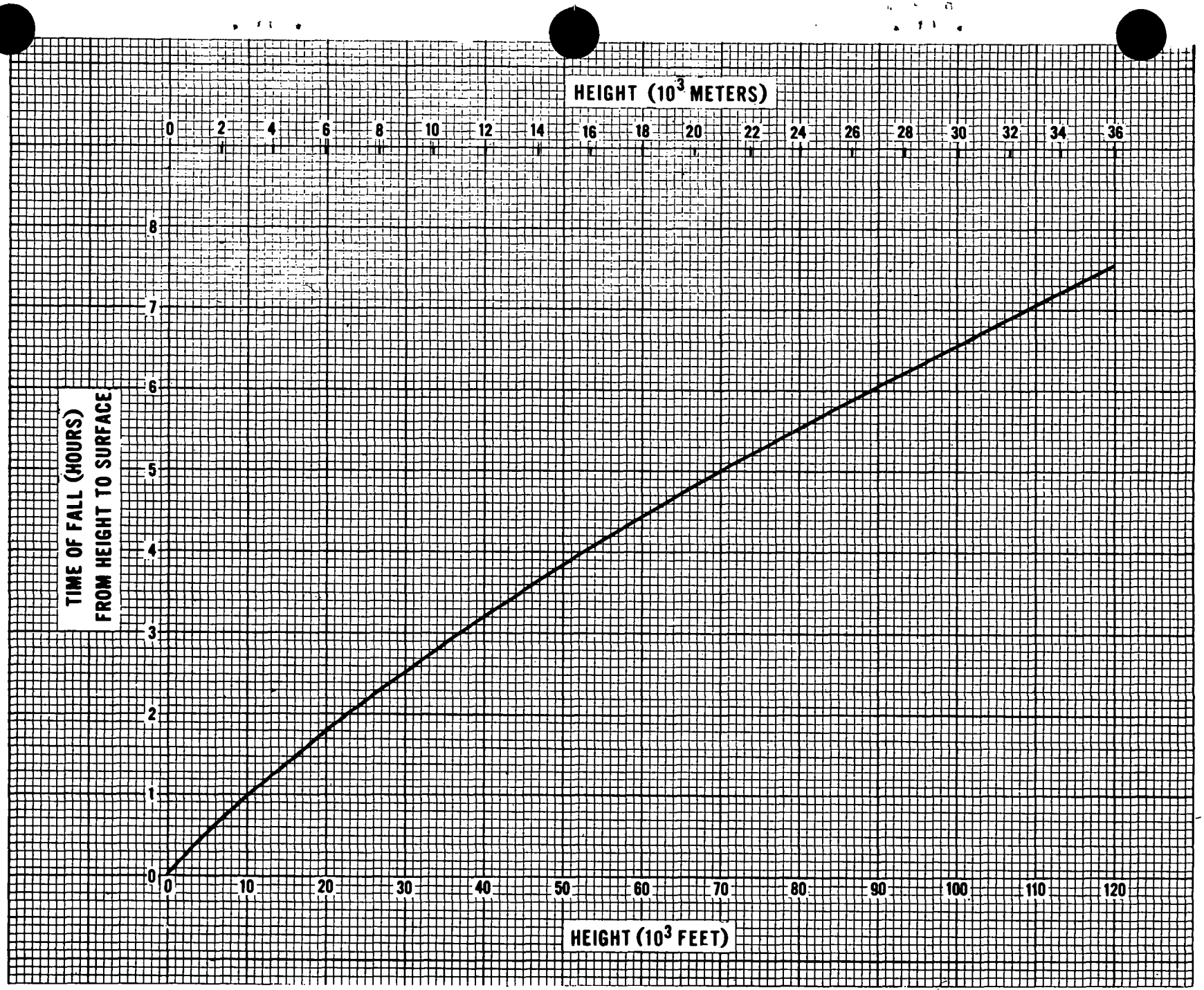


Figure 29. Time of fall (nominal size particle).

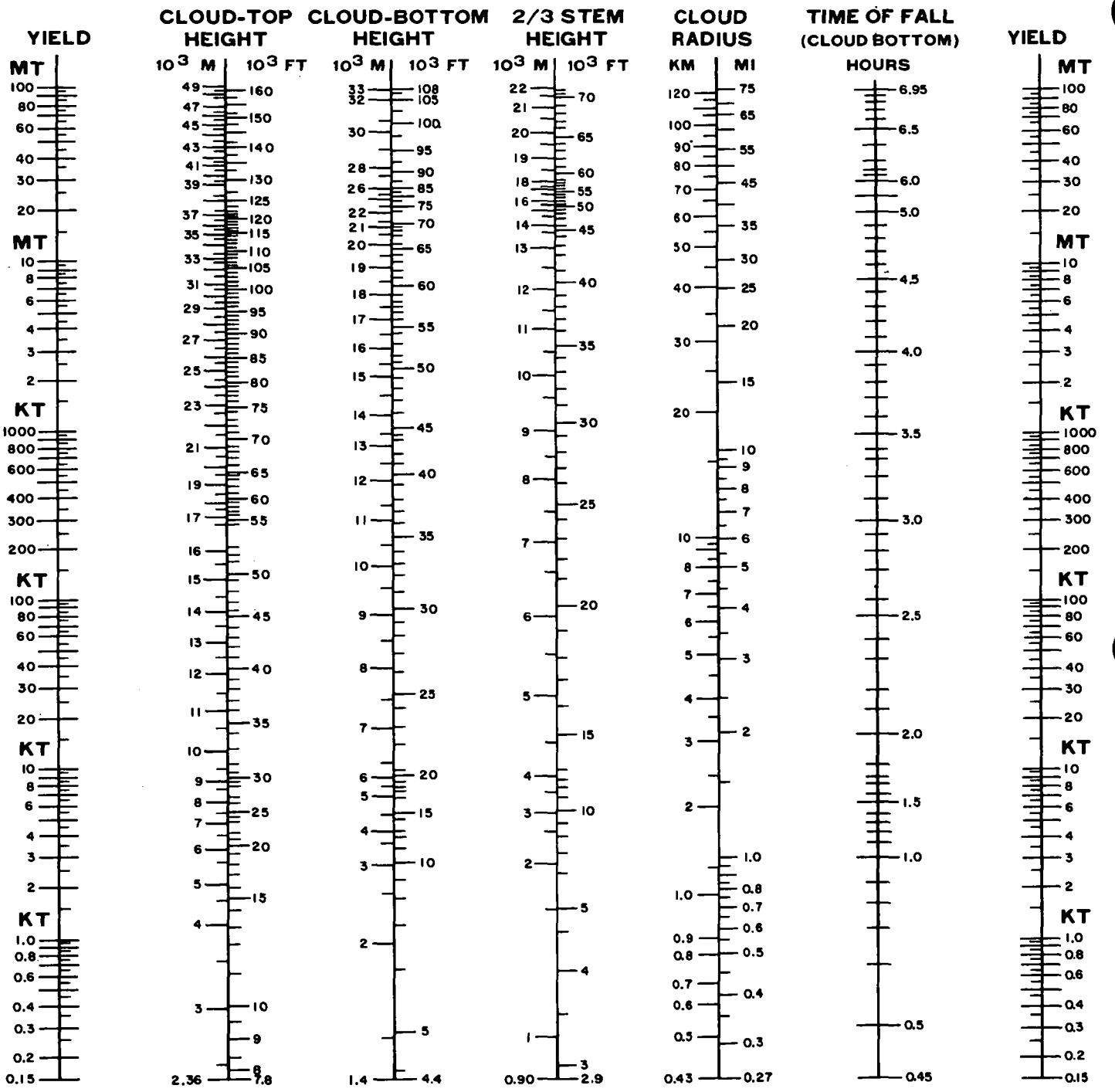


Figure 30. Radioactive cloud and stem parameters (stabilized at H + 10 minutes).

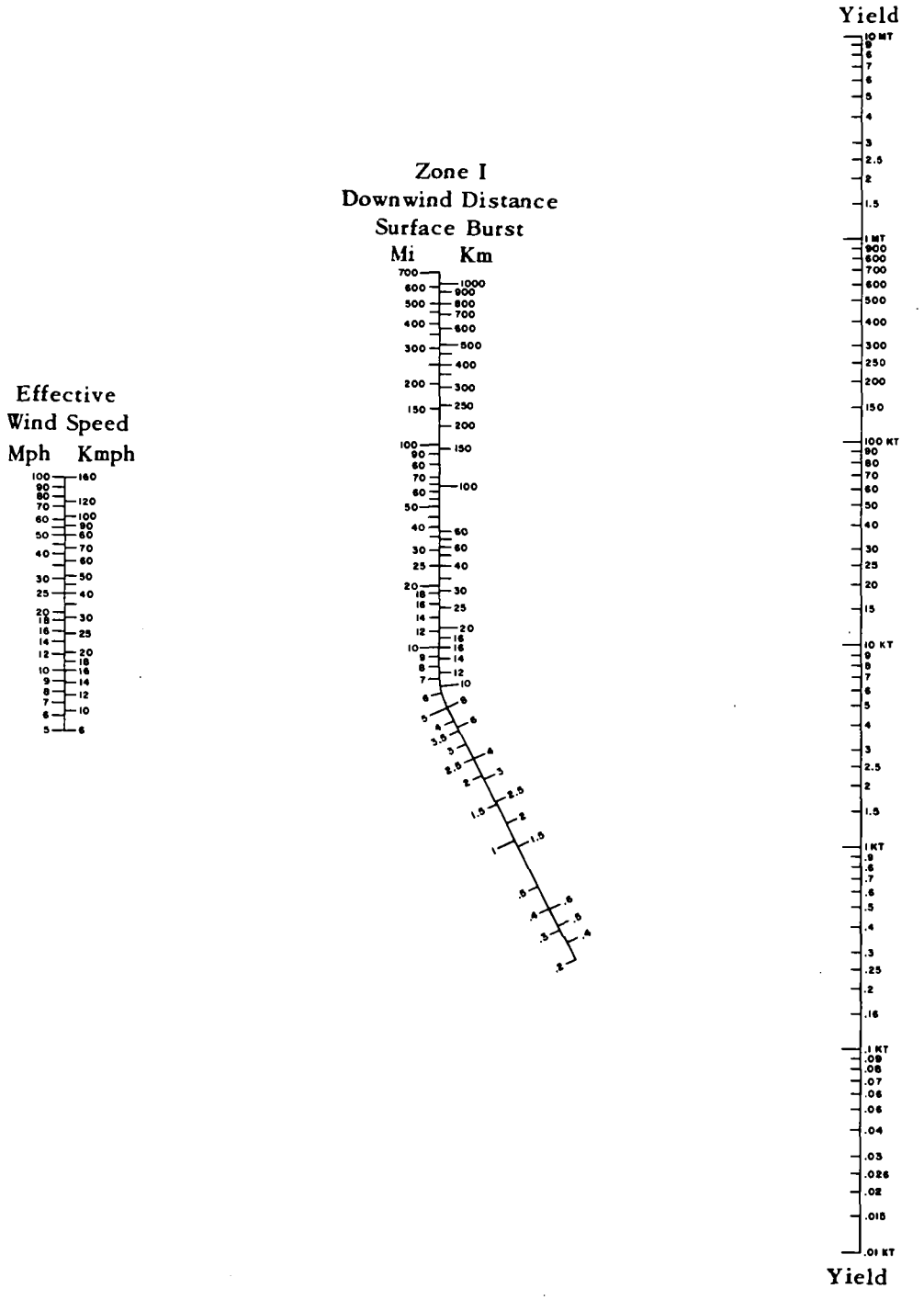


Figure 31. Zone I downwind distance, surface burst.

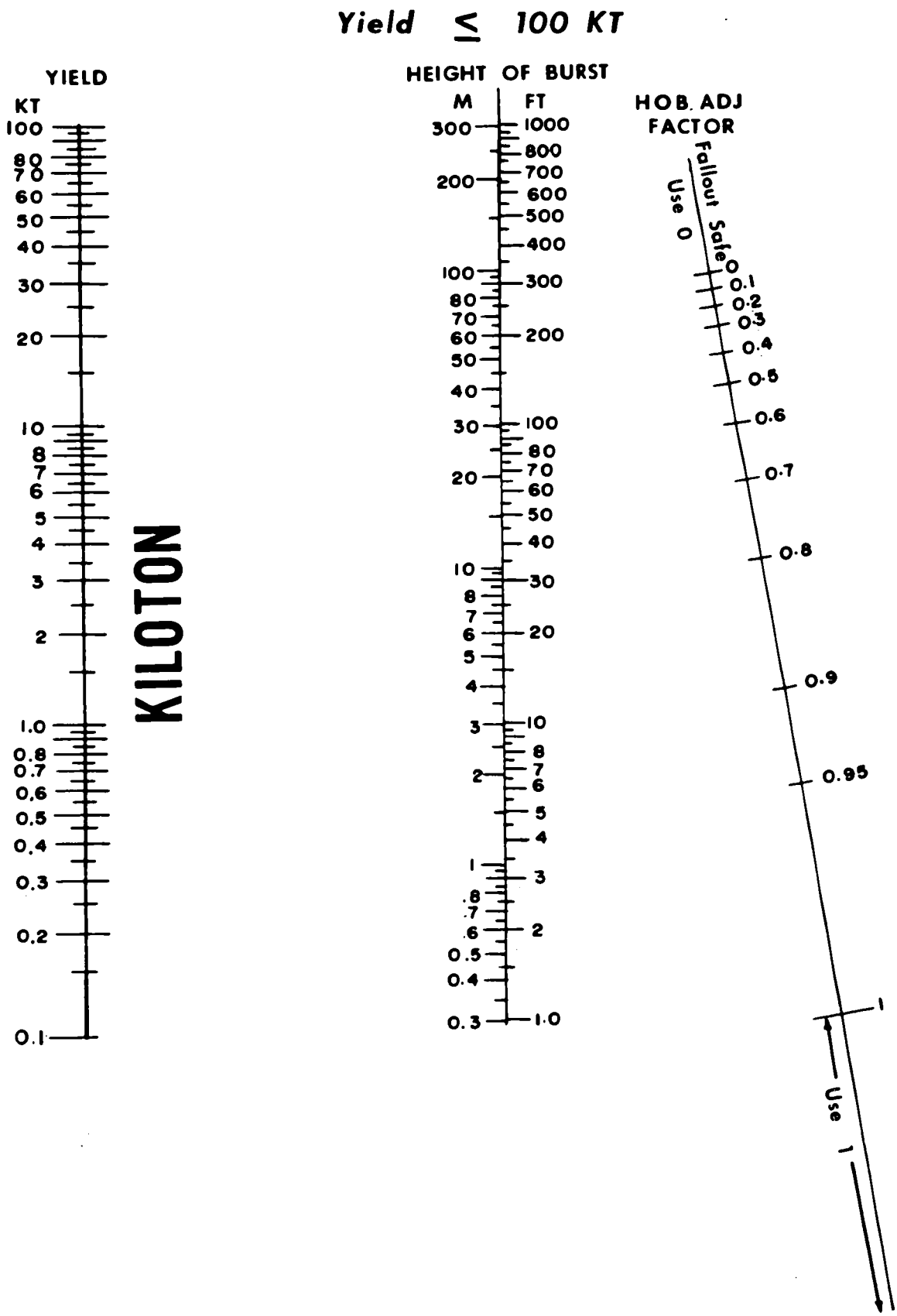


Figure 32. Height of burst adjustment factor, kiloton.

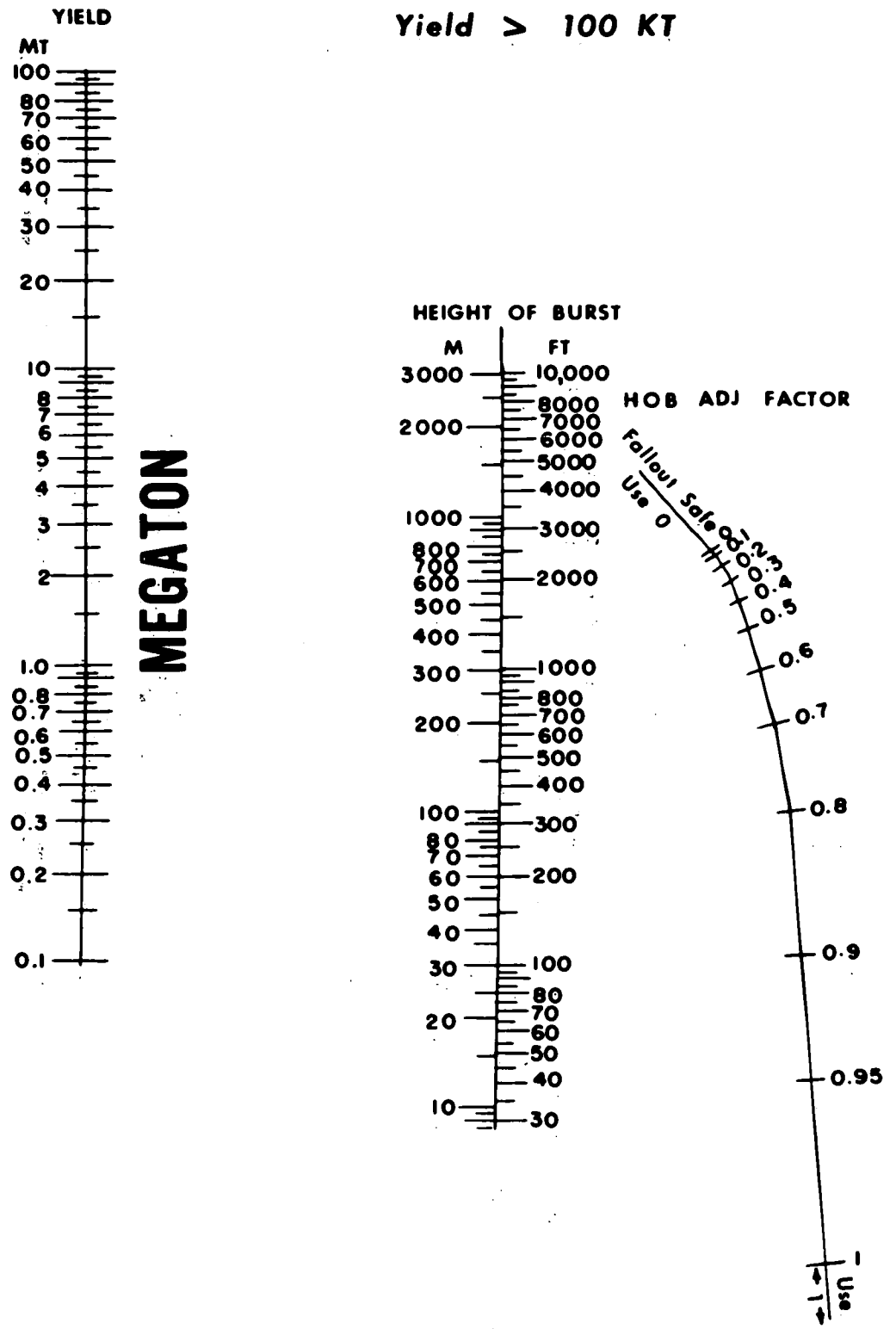


Figure 33. Height of burst adjustment factor, megaton.

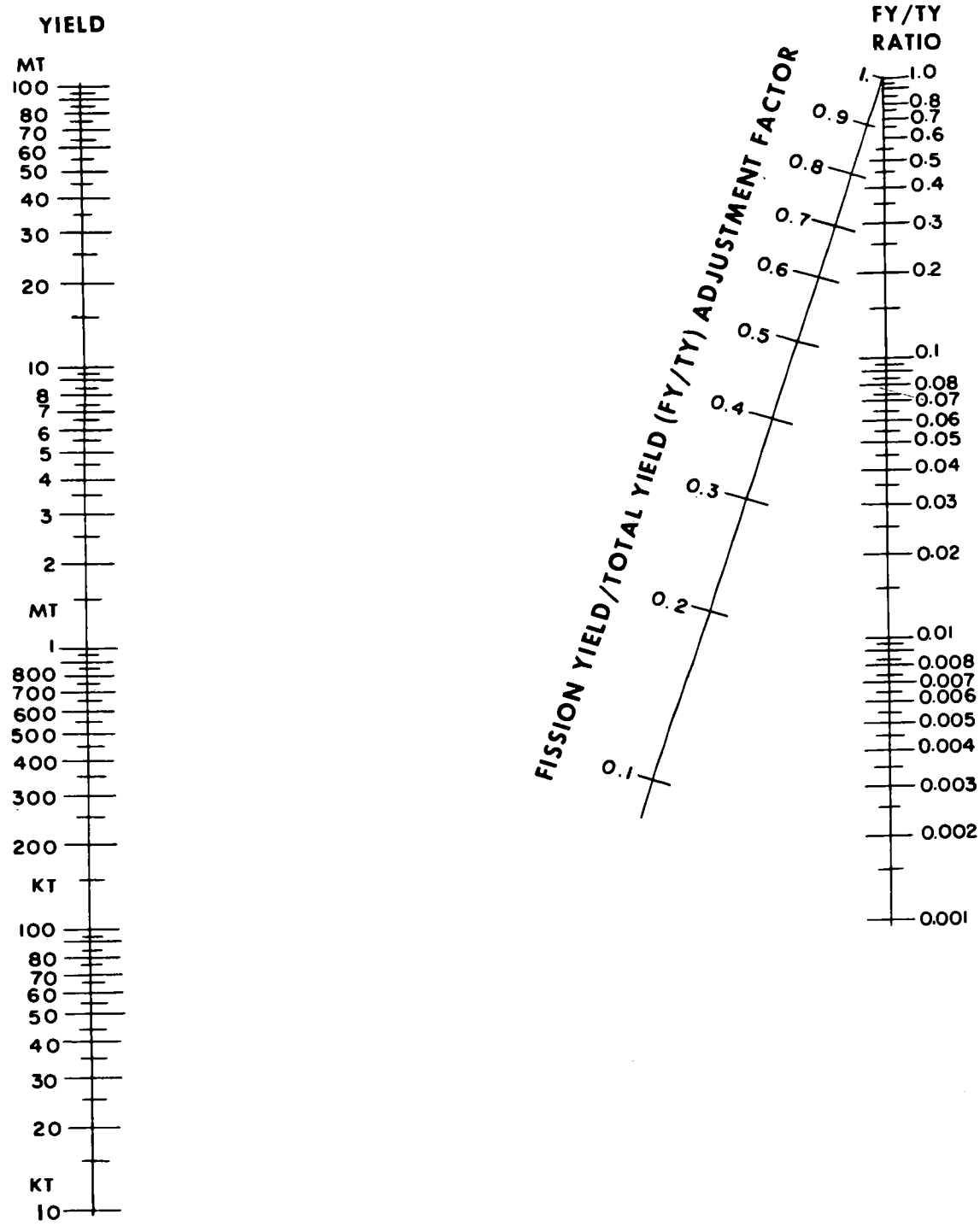


Figure 34. Fission yield/total yield (FY/TY) adjustment factor.

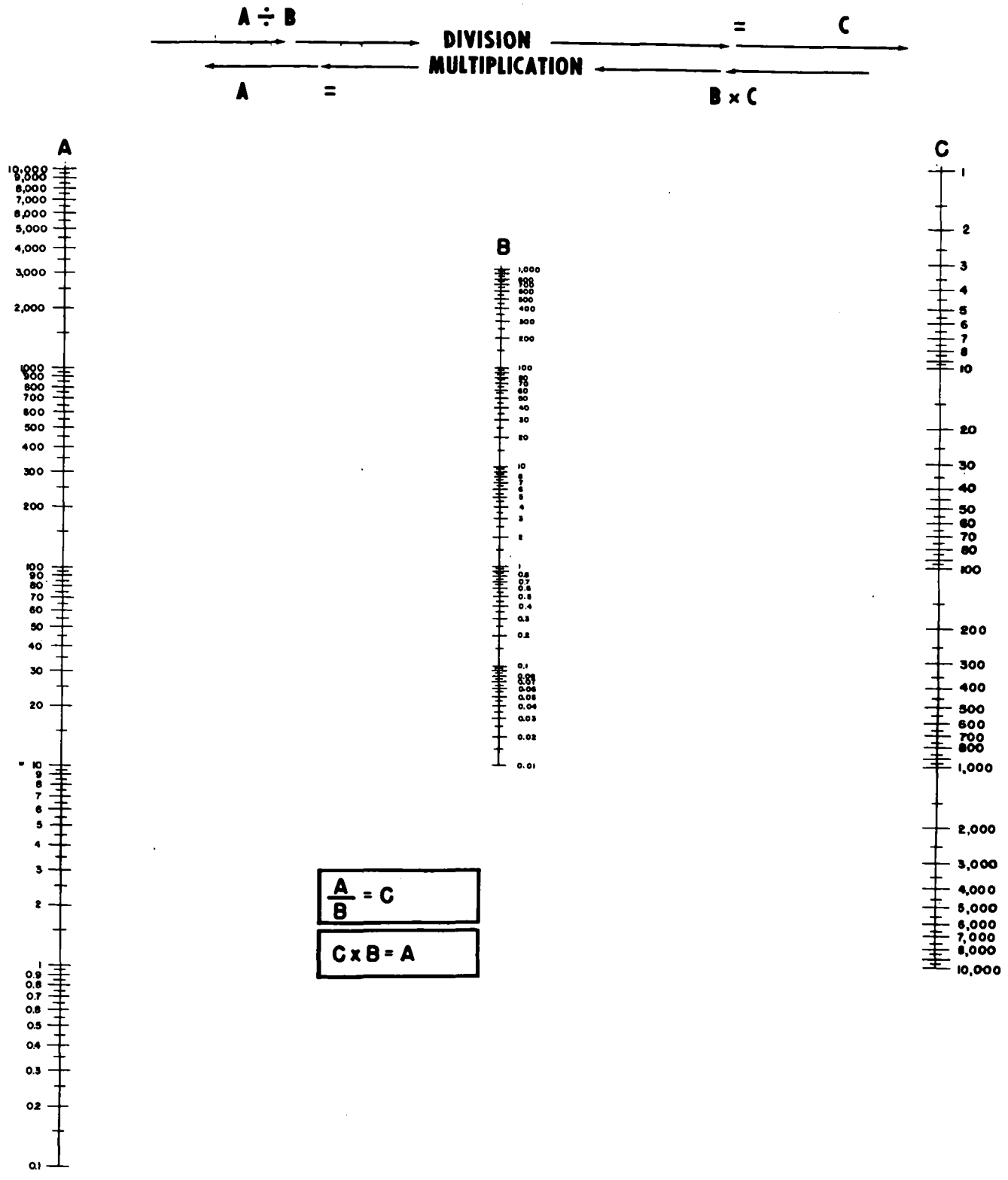


Figure 35. Multiplication-division nomogram.

30000155Z4

APPENDIX

REFERENCES

AR 310-25	Dictionary of United States Army Terms.
AR 310-50	Authorized Abbreviations and Brevity Codes.
AR 600-20	Army Command Policy and Procedure.
FM 3-12	Operational Aspects of Radiological Defense.
FM 5-26	Employment of Atomic Demolition Munitions (ADM).
FM 6-15	Artillery Meteorology.
FM 21-5	Military Training Management.
FM 21-6	Techniques of Military Instruction.
FM 21-30	Military Symbols.
TM 1-300	Meteorology for Army Aviation.
TM 3-6665-277-10	Operator's Manual: Area Predictor, Radiological Fallout, ABC-M5A1.
DA Pam 39-3	The Effects of Nuclear Weapons.

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